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4	644	(706/45).CCLS.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 17:04
5	118	(706/48).CCLS.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 17:04
6	222	(706/50).CCLS.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 17:04
7	7251	data near min\$3	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 17:05
8	570	gene near relationship	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 17:05
9	18	(data near min\$3) and (gene near relationship)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 17:05
-	4780	((autonomous or intelligen\$6) near2 (software or program\$6))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:06
-	1099	gene near2 value	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:07
-	27	((autonomous or intelligen\$6) near2 (software or program\$6)) and (gene near2 value)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:07
-	70977	gene near2 expression	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:07
-	759	((autonomous or intelligen\$6) near2 (software or program\$6)) and (gene near2 expression)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:08

	474	((autonomous or intelligen\$6) near2 (software or program\$6)) and (gene near2 expression)) and database	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:08
	13060	frequency near2 distribution	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:08
	4	((((autonomous or intelligen\$6) near2 (software or program\$6)) and (gene near2 expression)) and database) and (frequency near2 distribution)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:09
	45	hypothesiz\$6 near2 relationship	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:10
	12	(gene near2 expression) and (hypothesiz\$6 near2 relationship)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:10
	733	(gene near2 expression) and (data near2 min\$6)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:11
	7251	data near min\$3	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:15
	483	(gene near2 expression) and (data near min\$3)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:12
	16	((autonomous or intelligen\$6) near2 (software or program\$6)) and ((gene near2 expression) and (data near min\$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:12
	208789	data near (min\$3 or bas\$4)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:15
	570	gene near relationship	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:15
	88	(data near (min\$3 or bas\$4)) and (gene near relationship)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 15:15
	18	("5732218") or ("5892909") or ("5933818") or ("6012058") or ("6073138") or ("6112194") or ("6115708") or ("6151584") or ("6151601").PN.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/16 16:53

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2	1099	gene near2 value	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT;	2004/03/16 15:07
3	27	((autonomous or intelligen\$6) near2 (software or program\$6)) and (gene near2 value)	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT;	2004/03/16 15:07
4	70977	gene near2 expression	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT;	2004/03/16 15:07
5	759	((autonomous or intelligen\$6) near2 (software or program\$6)) and (gene near2 expression)	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT;	2004/03/16 15:08
6	474	((autonomous or intelligen\$6) near2 (software or program\$6)) and (gene near2 expression)) and database	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT;	2004/03/16 15:08
7	13060	frequency near2 distribution	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT;	2004/03/16 15:08
8	4	((autonomous or intelligen\$6) near2 (software or program\$6)) and (gene near2 expression)) and database) and (frequency near2 distribution)	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT;	2004/03/16 15:09
9	45	hypothesiz\$6 near2 relationship	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB USPAT;	2004/03/16 15:10
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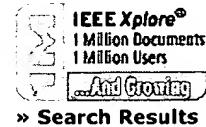
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2 Blocking formulae for the Engset model

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3 Hybrid analysis of response time distributions in queueing networks

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4 Enhanced interaction styles for user interfaces

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15 Page grammars and page parsing. A syntactic approach to document layout recognition

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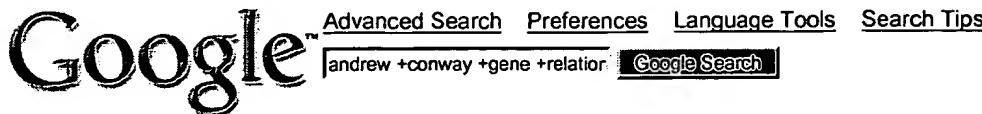
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Surnames

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University Letter

October 8, 1999**Volume 37 No. 7****UNIVERSITY LETTER**

University of North Dakota at Grand Forks
Vol. 37, Number 7, October 8, 1999

UNIVERSITY LETTER IS ALSO AVAILABLE ELECTRONICALLY in the Events and News section of UNDInfo, the University's menu system on the Internet. The address is: <http://www.und.nodak.edu/dept/our/uletter.htm>

The University Relations Office maintains an index for the University Letter.

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DID YOU KNOW?

UND's first purely decorative fixture was a fountain installed in 1907 by the Adelphi Society, the first student group organized on campus. The fountain has been refurbished and is set near the English Coulee.

PRESIDENT KUPCHELLA TO HEAD AMERICAN ASSOCIATION FOR CANCER EDUCATION

President Kupchella is about to accept an additional presidency -- as head of The American Association for Cancer Education (AACE).

Dr. Kupchella will spend Oct. 7-10 in Cleveland, Ohio, at AACE's 33rd annual meeting, where he will be installed as president of the organization, nearly six months after he was named president of the University of North Dakota.

AACE is comprised of individuals in cancer education; training within medical, dental, osteopathic, nursing, and public health schools; and other schools, institutions, or organizations which conduct cancer teaching and training programs.

This past year Kupchella served as chair of the AACE's annual meeting, and has been involved in cancer research for nearly 30 years. He has been active in AACE for the past 20 years.

"It is great to have been able to stay connected to my field of interest over a career largely in administration," said Kupchella. "The AACE has been especially rewarding because of its focus on assessment of the effectiveness of education in changing behavior and the uses of technology to enhance active involvement in learning. The AACE has dovetailed with my interests as a dean, provost and now president."

Kupchella's professional interest in cancer goes back to 1973-1979, when he was an associate professor of Oncology at the University of Louisville and was Associate Director of its Cancer Research Center.

In his research, Kupchella was one of the first to show that cold-blooded animals anticipate dormancy. He studied the effect of aspirin on the gastrointestinal tract and the properties of the extracellular matrix associated with the spread of cancer. Kupchella, who holds the rank of Professor of Biology at UND, has published widely in his field of expertise. He has written three books: "Sights and Sounds: The Very Special Senses" (Bobbs-Merrill Publishing Co., 1976); "Environmental Science: Living Within the System of Nature" (third edition, Prentice-Hall, 1993, with Peggy Hyland); and "Dimensions of Cancer" (Wadsworth Publishing Co., 1987).

KUPCHELLA BRIEFING RESCHEDULED

The President's Briefing referenced in Tuesday's Dakota Student has been rescheduled for Tuesday, Oct. 19, at 3:30 p.m. in the Memorial Union Lecture Bowl. Items on the agenda will include President Kupchella on the strategic planning process the University will undertake this year, and UND's plans for dealing with potential Y2K problems.

-- Jan Orvik, Editor, University Letter.

CLASSES CANCELED 1-4 P.M. OCT. 15 FOR INAUGURATION

Classes will be canceled from 1 to 4 p.m. Friday, Oct. 15, to provide an opportunity for faculty and students to participate in the inauguration of Dr. Charles E. Kupchella, the University's tenth president. Although classes will be canceled for the afternoon, the University will remain open.

The inauguration will highlight this year's UND Homecoming weekend. Events are being planned by a committee of campus and community members co-chaired by Robert Boyd, vice president of student and outreach services, and Earl Strinden, executive vice president of the UND Alumni Association and Foundation.

The main ceremony will take place at 2 p.m. in the Chester Fritz Auditorium. Official participants representing various constituencies of the University and other invited guests will march to the site from Wilkerson Hall, across the street, in a processional beginning at 1:30 p.m. The inauguration and a reception following it in Wilkerson Hall are open to the public. The inaugural events highlight Homecoming festivities as a welcome to the new president and his wife, Adele. Also among events will be the President's Luncheon at noon Saturday, Oct. 16, in the Memorial Union Ballroom, and the UND Homecoming and Inaugural Party at 8 p.m. Oct. 16 in the Grand Forks Civic Auditorium.

President Kupchella assumed the highest office of the largest educational institution in the region July 1, being named in a search that began last fall. President Kupchella had been provost at Southeast Missouri State University, Cape Girardeau.

The October ceremonies are the beginning of what will be an inaugural academic year of a "celebration of the University" through a series of events, culminating in the spring and including an inaugural tour of the state by President Kupchella. Spotlighted during the year's activities will be UND's people, academics, and research.

-- Robert Boyd, Vice President Division of Student and Outreach Services, and Earl Strinden, Executive Vice President of the UND Alumni Association and Foundation, Co-Chairs, Inauguration Committee.

FACULTY, STAFF INVITED TO INAUGURAL BANQUET

UND faculty and staff are invited to attend the Welcome and Inaugural Banquet Saturday, Oct. 16, being held in honor of the University of North Dakota's 10th President, Dr. Charles E. Kupchella. A full evening of fun is planned, including a musical performance by Dr. Kupchella and a special guest from the past who will bring to life the early founding days of the University. Your \$15 banquet ticket includes a prime rib dinner and admission to the Homecoming and Inaugural Party. Enjoy a night of dinner, dancing and great entertainment at the Civic Auditorium, 6 p.m. social, 6:30 p.m. dinner. You won't want to miss this! Reservations for the banquet can be purchased through the UND Alumni Association at 777-2611, PO Box 8157, University of North Dakota.

For more information, please contact me.

-- April Martin, Special Events Coordinator, Alumni Association, 777-3074.

BANQUET WILL HONOR JOHN PENN

Long time Speech Department professor and chair, John Penn (Dean Emeritus of Summer Sessions and Professor Emeritus of Speech), will be honored at the Sioux Awards Banquet Friday, Oct. 15. His career in the Speech Department at the University began in 1940. In 1949 he was appointed chair of that department and continued to serve in that capacity until 1967. He retired in 1978. His University activities included serving on numerous committees, including the Long Range Planning Committee, Student Affairs, Exchange Lecture Committee and the Academic Policies Committee. He chaired the Faculty Senate and served as faculty representative to the State Board of Higher Education. Over many years, he served on virtually every committee of significance at UND. He was a valued advisor to President Starcher and President Clifford. He quietly, but effectively, was involved in many important happenings on the campus and in the community. Come to honor John Penn at the Sioux Awards Banquet, 6:30 p.m. social, 7:15 p.m. dinner at the Westward Ho. You can make reservations by contacting the Alumni Association at 777-2611.

For more information, please contact me.

-- April Martin, Special Events Coordinator, Alumni Association, 777-3074.

BUDGET, GRANT FUNCTIONS REORGANIZED

Effective Oct. 1, the budget and grant functions of the institution were reorganized. The Budget and Grants Administration Office has been divided into two separate offices. Grant and Contract Administration, with David Schmidt as manager, now reports to the Controller within the Finance and Operations Division. Other staff in Grant and Contract Administration include Sally Horner, Marsha Tonder, Diane Hillebrand, Corey Graves and Lydia Whisenant. This office will continue to provide services related to grant and contract administration including proposal review, award negotiation and set-up, financial reporting and other similar types of services.

Recharge center, facilities and administrative rate (indirect cost) and other rate/costing issues will now be handled by the Budget Office. The Budget Office under the direction of Alice Brekke will continue to report to the President. Staff in the Budget Office includes Cindy Fetsch, Dawn Pladson and Rosemary Thue. Pladson will transition into the rate/costing functions as the reassignment of her portfolio of grant funds occurs. Finally, we would like to welcome Corey Graves as a Grant Officer within Grant and Contract Administration. Graves has been hired to fill a position which has been vacant for almost three years. The initial recruitment was interrupted by the flood of 1997.

We look forward to the opportunity to continue to provide services within the University community, and, as always welcome your comments and suggestions on how these services can be improved.

-- Alice Brekke, Assistant to the President and Director of Budget, and Pam Hurdelbrink, Controller.

EVENTS TO NOTE

FALL PLANTING TIPS, KIDS IN SPORTS FEATURED ON STUDIO ONE

Darlene Shea from Shea's Nursery in Grand Forks will demonstrate how to prepare perennial bulbs for the winter months on the Thursday, Oct. 7, edition of "Studio One" live at 5 p.m. on Channel 3 in Grand Forks. Shea's Nursery will celebrate its 20th anniversary this year. Shea will be giving tips and answer questions that are frequently asked during the fall planting season.

"Studio One" will also look at the importance of the relationship between parents and their children who compete in sports. Sports are a part of every school system and parents play a key role in how kids feel about playing sports. "Studio One" will talk with parents, kids and a psychologist who will give advice to parents who have kids in sports.

"Studio One" is an award-winning news and information program produced at the UND Television Center. The program airs live on UND Channel 3 on Thursdays. Rebroadcasts can be seen Thursdays and Fridays at 7 p.m., Saturdays at 10 a.m. and noon, as well as Monday through Wednesday at 7 p.m. Prairie Public Television airs "Studio One" on Saturday at 6:00 a.m. The program can also be seen in Fargo, Bismarck/Mandan, Minot, and Minneapolis.

-- Marla Johnson, UND Studio One Marketing Team.

BIOMEDICAL SCIENCE SEMINAR OPEN TO ALL

Faculty, staff and students are invited to attend a seminar series for BIMD 512: Foundations of Biomedical Science from 1 to 2 p.m. Fridays in 5510 School of Medicine and Health Sciences. The course is an interdisciplinary seminar series for first-year medical school department graduate students in basic sciences. The goal of the series is to showcase research.

The Friday, Oct. 8, seminar is "Dorsalizing Factors and the Establishment of Body Plan," presented by Al Candia, Department of Developmental Biology, Stanford University. Everyone is welcome to attend.

-- Jon Jackson, Anatomy and Cell Biology.

PHYSICS DEPARTMENT PLANS COLLOQUIUM

The Physics Department will hold a colloquium in which Howard Blackstead of Notre Dame University will present "Implications of Superconductivity in PrBa₂Cu₃O₇" at 3:30 p.m. Friday, Oct. 8, in 209 Witmer Hall. Coffee and cookies are served at 3 p.m. in 215 Witmer Hall. Everyone is welcome.

-- Tar-Pin Chen, Physics.

GRADUATE COMMITTEE MEETS MONDAY

The Graduate Committee will meet Monday, Oct. 11, at 3:05 p.m. in 305 Twamley Hall. The agenda will include:

1. Consideration of a request by the College of Education to add a new course, T & L 514, Intervention Strategies with Infants & Toddlers.
2. Discussion of new programs in Public Administration, Communication Sciences and Disorders, and Education.
3. Matters arising.

-- Harvey Knull, Dean, Graduate School.

MAYVILLE PROFESSOR WILL DISCUSS COMPUTATIONAL ETHOLOGY

The next presentation in the Computer Science colloquium series will be at 4 p.m. Monday, Oct. 11, in 108 Streibel Hall. Our speaker is Karl Altenburg from Mayville State University, who will present "Multiple Minimalist Agents: Robots and Metaphors for Computational Ethology." Dr. Altenburg's research interests include artificial life, animal behavior, and mobile robotics. He earned a B.A. in computer science from Concordia College, Moorhead, and an M.S. in general science, and a Ph.D. in zoology from North Dakota State University.

-- Tom Wiggen, Computer Science.

ANATOMY AND CELL BIOLOGY WILL HOLD SEMINAR

The Department of Anatomy and Cell Biology fall seminar series continues. Al Candia, Department of Developmental Biology, Stanford University, will present "Regulation of the LET-23 EGF Receptor and Vulval Development in *c. Elegans*" at noon Monday, Oct. 11, in B710, Edwin C. James Medical Research Facility, School of Medicine and Health Sciences.

-- Jon Jackson, Series Coordinator, Anatomy and Cell Biology.

MEMORIAL UNION LISTS OCTOBER EVENTS

The Memorial Union has a number of events scheduled this month as part of the new series, "Because It's the Union," for UND students, faculty and staff. The series continues Monday, Oct. 11, at noon with a discussion on "Everyday Etiquette" led by Mae Marie Blackmore in the Leadership Inspiration Center on the third floor of the Memorial Union. Nancy Yoshida will bring the October events in the series to a close with a demonstration on how to create and preserve your photo albums and scrapbooks in "Making Memories Last" Tuesday, Oct. 26, in the Memorial Room. "Because It's the Union" will continue in November with another schedule of entertaining, informative and fun activities to enjoy over your lunch break. Be sure to watch for more information and join us "Because It's the Union."

-- Hilary Bertsch, Coordinator of Special Programs and Marketing, Memorial Union.

COUNSELING PLANS TOPICS SEMINAR

The Department of Counseling will hold a Topics Seminar in Counseling Psychology Research and Practice, in which Don Daughtry (Counseling) will discuss "Men and Depression" from 12:30 to 1:45 p.m. Tuesday, Oct. 12, in 316 Montgomery Hall. Everyone is welcome.

-- Jane Hall, Coun 565N and Sue Jacobs, Supervising Professor, Counseling.

INSTRUCTIONAL AND LEARNING TECHNOLOGIES FACULTY WORKSHOP SESSIONS ANNOUNCED

The following Faculty Workshop sessions will be offered next week:

Tuesday, Oct. 12, 10 to 11:30 a.m., Slide and Flatbed Scanning; Wednesday, Oct. 13, 1 to 4 p.m., Adding Interactive and Multimedia Features With PowerPoint 2000; Thursday, Oct. 14, 9 to 10:30 a.m., Preparing Images for the Web

You may register online at <http://www.cilt.und.nodak.edu/services/index.html> or by calling 777-4150.

-- Lynn Weiner, Center for Instructional and Learning Technologies.

UNIVERSITY BAND, WIND ENSEMBLE WILL PRESENT FIRST CONCERT OF SEASON

The University Band and Wind Ensemble will present a concert at 7:30 p.m. Tuesday, Oct. 12, at the Empire Arts Center.

As part of our Millennium Tour concert season, we will be programming significant works by both American and European composers throughout the year. For this initial concert of the 1999-2000 season, the University Band will feature music from Spain, France, Norway, and Austria, while the Wind Ensemble will present William Schuman's exciting setting of the American Revolutionary tune, "Chester," Ronald LoPresti's tribute to John F. Kennedy, "Elegy for a Young American," and Percy Grainger's masterpiece for band, "Lincolnshire Posy."

The proceeds and donations from our concerts will assist us in our preparations for the Wind Ensemble tour of Great Britain in May of 2000. Admission is \$5 for adults, \$2 for students. All junior and senior high students will be admitted free of charge with the presentation of their student ID card.

-- Gordon Brock, Director of Bands.

THEATRE ARTS OPENS SEASON WITH IBSEN PRODUCTION

The Department of Theatre Arts opens the 1999-2000 main stage season with "Hedda Gabler" by Henrik Ibsen. A story of thwarted genius and anguished desire, Ibsen's "Hedda Gabler," written in 1890, remains one of the most startling dramas of the modern theatre. Hedda Gabler lives in a world defined by and restricted to bourgeois respectability. Her natural ambition and spirit are crushed by both social expectations and her own restraint. She struggles to rise above these destructive forces only to be pulled further and further toward her tragic doom.

Stacie Joy Erickson plays Hedda Gabler; Larry Outhwaite appears as George Tesman, Hedda's husband; Mary Ann Kabaker returns to Grand Forks in the role of George's aunt, Miss Juliana Tesman; and Michelle Davidson plays Hedda's maid. Judge Brack, played by David Henry, controls the community with his manipulative hand. Standing in contrast to the respectable social world of Christina, Norway, is Eilert Lovborg, played by Damian Hultgren. Eilert's genius and lust for life have driven him to alcoholism from which he has recovered with the help of a companion, Thea Elvstead, played by Danielle Weiser. Behind the action of the play burns a passionate love between Hedda and Eilert that cannot be fulfilled.

The public is invited to a free lecture by Ibsen Scholar Professor Mary Kay Norseng from the University of California-Berkeley to be held Wednesday, Oct. 13, at 4 p.m. in the Burtress Theatre. On Thursday, Oct. 14, Professor Norseng will be joined by a panel of UND faculty to continue a discussion of Ibsen and his work. The panel discussion is at 4 p.m., also in the Burtress Theatre.

The UND production is directed by Theatre Arts Chair Kathleen McLennan and designed by Greg Gillette with senior Beth Froelich as stage manager. Cory Johnson is the student lighting designer. The production opens Tuesday, Oct. 12, and runs through Saturday Oct. 16. All performances are at 7:30 p.m. Tickets are \$5. To reserve tickets call the Burtress Theatre Box office at 777-2587.

-- Kathleen McLennan, Chair, Theatre Arts.

RETIRED FACULTY MEMBERS MEET MONTHLY

Members of the retired faculty have resumed meetings on the second Thursday of each month. The next meeting will be at 7:30 a.m. Thursday, Oct. 14, in the Sioux Room of the Memorial Union with the table topic "My response to Y2K."

-- Lloyd Omdahl, Associate, Bureau of Governmental Affairs.

FREE DEFENSIVE DRIVING COURSE OFFERED

A free Defensive Driving Course for UND employees and a member of their family will be held Wednesday, Oct. 13, from 8:30 a.m. to 12:30 p.m. at 211 Rural Technology Center. We will hold a subsequent class Tuesday, Oct. 26, from 12:30 to 4:30 p.m. in the same location. This course may reduce your North Dakota insurance premiums and could possibly take away points from your driving record. Please call the Safety Office at 777-3341 to register and for directions.

-- Corrinne Kjelstrom, Safety Office.

INTERNATIONAL CENTRE LISTS PROGRAMS

The International Centre will celebrate Japan Night at 7 p.m. Thursday, Oct. 14, at the International Centre, 2908 University Ave. On Saturday, Oct. 16, the Centre will have a Pumpkin Pie Party following the Homecoming Parade.

-- International Centre.

SEMINAR WILL FEATURE GLOBAL CLIMATE CHANGE

A noon seminar Friday, Oct. 15, in the Leonard Hall Lecture Bowl will feature "Geologic Constraints on Global Climate Change," presented by Lee Gerhard, Kansas Geological Survey, in honor of 1999 Arthur Gray Leonard Award recipient Tom Hamilton (M.S. 1967, Ph.D. 1970, Hon 1993). All interested persons are welcome to attend.

-- Richard LeFever, Chair, Geology and Geological Engineering.

BRIAN PAULSEN'S ARTWORK TO BE FOCUS OF CHILDREN'S ART WORKSHOP

The North Dakota Museum of Art continues its fall education program Saturday, Oct. 16, with the Art Studio Saturday workshop inspired by the paintings of Grand Forks artist Brian Paulsen. These workshops for children grades one through six and their parents/guardians are held on specific Saturdays each month from 10 a.m. to noon.

In this workshop, children will create drawings using perspective and pattern, which Paulsen uses masterfully. We will discuss the history of perspective, how to use perspective and how Paulsen has combined perspective and pattern. Each child will create an artwork in relationship to Paulsen's works. The fee for this workshop is \$5 per child for Museum members and \$7 per child for non-members.

Paulsen lives in Grand Forks and teaches drawing, lettering, painting and design at the University. He is one of the most consistent award-winning artists in the region and has served as a faculty member in the Visual Arts Department for more than 25 years. For years Paulsen has hand-painted exhibition signage on the walls of the North Dakota Museum of Art. He painted his own "painter's hand" for the Museum Donor Wall.

The Museum's Art Studio Saturdays are workshops focused on the current exhibits or works in the Permanent Collection. The class will discuss the history of the artist, the subject, style, materials and technique in the chosen artwork, and each child will make a work of art in relationship to the piece being discussed. The workshops will allow the parent/guardians and the children to become aware of contemporary art traditions and help them feel a part of the cultural heritage at the North Dakota Museum of Art.

Art Studio workshops continue Nov. 20 and Dec. 27, 28, 29. For more information, call (701) 777-4195.

The North Dakota Museum of Art is on Centennial Drive on the campus of the University of North Dakota. Hours are 9 a.m.

to 5 p.m., Monday through Friday, and 1 p.m. to 5 p.m., Saturday and Sunday. There is no charge for admission.

-- Morgan Owens, North Dakota Museum of Art.

ND CLOTHESLINE PROJECT ON DISPLAY OCT. 18-21

The fifth annual display of the ND Clothesline Project will be Monday, Oct. 18, through Thursday, Oct. 21, in the South Ballroom of the Memorial Union from 9 a.m. to 9 p.m. daily.

In conjunction with the week's events, Ellen Snortland, author of "Beauty Bites Beast: Awakening the Warrior Within Women & Girls," will give a presentation titled "Awaken Your Inner Warrior" at 7 p.m. Wednesday, Oct. 20, in the Lecture Bowl, Memorial Union.

The Take Back The Night Rally and March will begin Thursday, Oct. 21, at 7 p.m. in the Fireside Lounge, Memorial Union.

If you would like more information about the Clothesline Project, please call the Women's Center at 777-4300.

-- Kay Mendick, Interim Coordinator, Women's Center.

FLU SHOTS AVAILABLE FOR UND EMPLOYEES

Student Health Services will give flu shots free to employees with Blue Cross/Blue Shield Insurance. Please bring your policy number with you. Dates and times for the shot clinics follow:

Tuesday, Oct. 26, 7 a.m. to 2 p.m., Facilities Lunch Room; Thursday, Oct. 28, 10:30 a.m. to 5:30 p.m., McCannel Hall Atrium; Thursday, Nov. 4, 8 to 10 a.m., 111 Odegard Hall; Thursday, Nov. 4, 10:45 a.m. to 1 p.m., 305 Twamley Hall; Thursday, Nov. 4, 1:45 to 3:45 p.m., Energy and Environmental Research Center Conference Room, second floor.

Federal employees will be billed individually.

-- Sue Bartley, Student Health Services.

OF ACADEMIC INTEREST

APPLICATIONS DUE FOR 2000-2001 DEVELOPMENTAL LEAVES

Eligible faculty and staff who wish to apply for developmental leave projects during academic year 2000-2001 may submit proposals to the faculty member's chair and dean or the staff member's administrative supervisor according to the announced schedule. After review, recommendations and prioritizing at the college and/or administrative supervisory level, all proposals will then be forwarded to the Office of the Vice President for Academic Affairs on or before Monday, Nov. 8, for review by the Vice President for Academic Affairs and Provost. Following presidential approval, applicants will be given notice of an approved or disapproved developmental leave. Confirmed and final approval of the proposals will depend upon the University's 2000-2001 salary budget being approved by the State Board of Higher Education.

As in the past, developmental leaves which are approved must be funded within existing departmental and college resources. Thus, it is likely that some very sound proposals may not be approved for budgetary reasons. Faculty and staff who expect to submit requests for developmental leaves should discuss plans with their chairpersons, deans, and/or supervisors prior to formally submitting their proposals.

Developmental leave applications and copies of the State Board of Higher Education Policy 701.2 governing developmental leaves are available in the Office of Academic Affairs, Room 302, Twamley Hall.

-- John Ettling, Interim Vice President for Academic Affairs and Provost.

TRAVEL FUNDS AVAILABLE FOR WORKSHOP ON PROTECTING HUMAN SUBJECTS

Arizona State University will host a workshop to explore contemporary issues in human subjects protection in research involving minorities, children, and other vulnerable populations. The workshop is Nov. 10-12 at the Holiday Inn in Tempe, Ariz. Sponsors include the Office of Protection from Research Risks, the National Institute on Drug Abuse and the Food and Drug Administration.

The workshop is a practical working session where faculty will present topics from different perspectives. Additional panel sessions will allow for audience questions and discussions. Participants are expected to be researchers in the behavioral and social sciences, Institutional Review Board members, university administrators, lawyers, ethicists, health care practitioners, students, and others interested in human subject protection issues.

The Office of Research and Program Development (ORPD) will assist in travel funds for faculty or staff members who would like to attend this workshop. More information, including the registration form, is available online at http://researchnet.asu.edu/human_subjects/workshop99/index.html. Those requesting travel funds should contact ORPD as soon as possible.

-- Sally Eckert-Tilotta, Associate Director of Research and Program Development.

DOCTORAL EXAMS SET FOR HEGSTAD AND O'DONNELL

The final examination for Holly Hegstad, a candidate for the Ph.D. degree with a major in Clinical Psychology, is set for 3 p.m. Monday, Oct. 18, in 203 Corwin-Larimore Hall. The dissertation title is "Predicting Post-Disaster Adjustment After the Red River Flood of 1997: An Analysis of Resource Loss and Pre-Flood Preventive Behavior." Doug McDonald (Psychology) is the committee chair.

The final examination for Barbara D. O'Donnell, a candidate for the Ed.D. degree with a major in Teaching and Learning, is set for 8:30 a.m. Monday, Nov. 8, in Room 104, Education Building. The dissertation title is "A Story Problem: How to Teach Mathematics Methods in an Undergraduate Teacher Education Program." Shelby Barrentine (Teaching and Learning) is the committee chair.

Members of the Graduate Faculty are invited to attend.

-- Harvey Knull, Dean, Graduate School.

ANNOUNCEMENTS

NEW STUDENT PROFILE AVAILABLE

Attached to this issue of University Letter is the 1999-2000 edition of the UND Student Profile. It contains information on enrollment, statistics on gender, age, ethnicity, geographic origin, levels of study, and more. It is also available online at <http://www.und.edu/general/profile.htm>. If you'd like a paper copy, please call the Office of University Relations at 777-2731.

--Jan Orvik, Writer/Editor, University Relations.

LEAVE DONATIONS SOUGHT FOR SHARON STEINKE

Leave donations are sought for Sharon Steinke, an employee in Squires Dining Center. She will be unable to work for about six months. If you are interested in donating leave, please pick up a form at the Dining Services Administration building or Personnel/Payroll, 313 Twamley Hall. The completed forms may be returned to either office. Your assistance will be greatly appreciated.

-- Lola Conley, Account Technician, Dining Services.

STAFF SENATE RUMMAGE SALE A SUCCESS

The Staff Senate would like to thank everyone who donated items for the Fundraising/Scholarship Rummage Sale. A special thank you to all who volunteered to work and to the staff of the Chester Fritz Auditorium for the use of their building, tables and time. The sale was a big success and we plan to make it an annual event. Proceeds will be used to fund student scholarships.

-- Sherri Korynta (Student and Outreach Services), UND Staff Senate.

CREDIT UNION OFFERS FREE PORTRAITS

University Federal Credit Union invites you to take advantage of our free portrait offer. A professional photographer will take an 8 x 10-inch portrait of you and your family. It is yours to keep with no cost obligation. Call 777-2274 at once to set up your portrait setting; an appointment is necessary. There are a few openings still available on Thursday, Friday, and Saturday, Oct. 7, 8 and 9. Additional finished portraits will be available from the portrait company in three to four weeks after your sitting at special low prices. This is just another Credit Union benefit.

-- George Meister, Manager, University Federal Credit Union.

OKTOBERFEST SCHEDULED FOR OCT. 9TH AT THE EMPIRE

The Greater Grand Forks Symphony's Oktoberfest will take place this year at the Empire Arts Center Saturday, Oct. 9, at 7 p.m. The opening event for the Symphony's 91st season is a gala celebration of Viennese music and food. Maestro Timm Rolek begins his fifth year in Grand Forks with the music of Waltz King Johann Strauss in honor of the 100th anniversary of Strauss' death. The first half of the program will be devoted to some of Strauss' best-known and best-loved works, including "The Emperor Waltz," "Roses from the South," "Tales from the Vienna Woods," and the "Blue Danube Waltz." The second half will be a performance of Act II of the quintessential Viennese operetta and Strauss's comic masterpiece, "Die Fledermaus" (The Bat). Before, between and following the concert, fine Austrian desserts, coffees and German beers and wines will be served in the Empire Gallery.

In addition to the orchestra, this year's performance brings a number of familiar vocalists to the stage of the Empire. Maria Williams will sing the role of Rosalinda. Ms. Williams has recently returned to the city to open her own voice studio after teaching in Indiana. She will be joined on stage by Kathryn Ring, a graduate of East Grand Forks Senior High and UND. Appearing with Ms. Williams and Ms. Ring will be Todd Queen, a Fargo tenor who has performed with the Eastman Opera Theater and Portland Opera Repertory. Also included in the performance are choral singers from the Grand Forks Central Concert Choir under the direction of Charles McCauley.

Tickets for the 1999 Oktoberfest are available from the Symphony office; Room 162, Hughes Fine Arts Center (777-3359); or from the Empire Box Office at 746-5500 (9 a.m. to 4 p.m. Tuesday through Saturday and 9 a.m. to 7 p.m. on Thursday).

-- Greater Grand Forks Symphony Orchestra.

SATELLITE SEMINAR WILL FEATURE LIBRARIES, COPYRIGHT AND INTERNET

You're invited to attend "Libraries, Copyright, and the Internet" via satellite from 1:30 to 3:30 p.m. Thursday, Oct. 14, in the Memorial Union Lecture Bowl.

With Internet access becoming a key service of libraries everywhere, librarians need to know the basics of copyright law. This program will cut through the myths and misinformation about the way fair use and cyberspace law apply in a library setting restrictions that are truly necessary to avoid the risk of lawsuits the liabilities of patrons, librarians, and libraries.

A follow-up to the award-winning "Am I A Crook?" satellite event, this program is essential for all academic, school, and public libraries. Access additional information about this program including panelists bios at <http://www.pbs.org/adultlearning/als/dallas99/libraries/index.html>

You are invited to attend the first of four live satellite events which will explore issues in higher education and the Internet. These four programs will explore how the Internet has changed teaching and learning, the classroom, and libraries. The events are produced by Dallas Telelearning and the Public Broadcasting Service and sponsored at UND by Vice President for Academic Affairs and Provost, the Chester Fritz Library, the Center for Instructional and Learning Technologies,

Continuing Education, and the Computer Center.

Additional events in the series are which will also be offered on the UND campus are: "Online Testing: Assessing and Evaluating Distance Learners," "Virtual Universities: Online and On-Target?" and "How to Customize an Online Course."

See <http://www.pbs.org/adultlearning/als/dallas99/index.html> for dates and additional information.

-- Dorette Kerian, Interim Director, Computer Center, and James Shaeffer, Dean of Outreach Programs.

CHESTER FRITZ LIBRARY TO HOLD BOOKSALE

The Chester Fritz Library will hold its annual book sale Thursday, Oct. 14, from 10 a.m. to 3 p.m. inside the Library's north entrance facing University Avenue.

-- Cynthia Shabb, Chief Bibliographer, Chester Fritz Library.

GRANTS AND FELLOWSHIPS

SCHOLARLY ACTIVITIES COMMITTEE SEEKS PROPOSALS BY OCT. 19

Tuesday, Oct. 19, is the first deadline for submission of applications to the Senate Scholarly Activities Committee (SSAC) (formerly the Faculty Research and Creative Activity Committee). The Committee will consider requests from faculty members to support: (1) research, creative activity or other types of scholarly endeavors; (2) travel associated with research activities or the presentation of scholarly papers; and (3) publication costs. Travel requests will be considered only for travel to be completed before Jan. 18, 2000.

The Committee will not provide funds for travel already completed. However, awards can be made contingent on receipt of a letter of acceptance from the meeting at which a paper is to be presented or a program listing the applicant among the presenters. Therefore, if you will be traveling during the specified dates, but do not yet have a letter of acceptance, please do submit your application at this time. If an award is made, an account will be set up for you after you submit proper evidence of acceptance for presentation. Requests for support to improve or supplement instructional activities will not be considered since applicants should request those funds from the Office of Instructional Development.

The Committee reminds applicants to carefully prepare their proposals and be specific and realistic in their budget requests. The proposal should be written with a multidisciplinary readership in mind. Avoid technical jargon and undefined abbreviations. Although the SSAC encourages submission of research/creative activity proposals and travel/publication requests, the Committee takes into consideration the most recent SSAC (and FRCAC) awards granted to each applicant. Priority will be given to beginning faculty and first-time applicants. Requests for research/creative activity awards may not exceed \$2,500. The Committee has approximately \$55,000 available to award during the 1999-00 academic year.

Application forms are available at the Office of Research and Program Development (ORPD), 105 Twamley Hall, 777-4279, or on ORPD's Homepage (on UND's Homepage under "Research"). A properly signed original and seven copies of the application must be submitted to ORPD prior to the deadline. Applications that are not prepared in accordance with the directions on the forms will not be considered by the Committee. Please feel free to contact any of the current SSAC committee members for information or guidance when preparing your application. Their names, telephone numbers, and e-mail addresses are available on ORPD's Homepage or by calling ORPD at 777-4279.

-- Clifford Staples (Sociology), Chair, Senate Scholarly Activities Committee.

DEADLINE EXTENDED FOR EPSCoR PRE-PROPOSALS

The National Science Foundation (NSF) has very recently made substantial changes to the EPSCoR Standard Grant Program that are not on its web page. The major change is that EPSCoR Standard Grant pre-proposals will not be submitted to NSF as originally required. Consequently, there is more time available to prepare pre-proposals.

Following is a general description of the program:

The grants are for up to \$500,000/2 yrs. (matching dollars are not required and indirect costs are allowed) to provide "venture capital" to initiate projects consistent with state and institutional S&T improvement strategies and with high potential for significant short-term impact on the state's research competitiveness. (EPSCoR grant proposals that involve more than one EPSCoR state have a budget limit of \$750,000/2 years will not be counted as one of two submissions permitted.) The project should be of the type for which there is no presently defined source of funding at NSF (i.e., a research directorate or specifically targeted program).

Five copies of the pre-proposal, up to five pages including the budget page, no special format required, are due in one of the EPSCoR offices by noon Tuesday, Oct. 26. UND's EPSCoR office is located in 415 Twamley Hall. Pre-proposals must receive the appropriate institutional signatures prior to submission to ND EPSCoR.

An ad hoc committee selected by the ND EPSCoR steering committee will select two pre-proposals for expansion to full proposals to be submitted to NSF (due date: Jan. 14, 2000).

The pre-proposals should address, at the minimum, the three points below:

- 1) The imaginative and innovative nature of the project and its impact on research competitiveness.
- 2) The mechanism by which the proposed activity will be maintained after the NSF grant.
- 3) The proposed budget.

-- David Givers, ND EPSCoR, Fargo.

NSF CRITERIA EMPHASIZES BOTH INTELLECTUAL MERIT AND BROADER IMPACTS OF RESEARCH

In a recent news release, National Science Foundation (NSF) director Rita R. Colwell reiterated the criteria used to review proposals submitted to the Foundation for funding, but specifically addressed the need for both proposal preparers and evaluators to consider the broader impacts of the research proposed. Evidently, investigators have been neglecting the second criterion when writing proposals, and reviewers have done the same. The two criteria used to evaluate proposals are listed in NSF's Grant Proposal Guide (00-02):

Criterion 1: What Is the Intellectual Merit of the Proposed Activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer to conduct the project? To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

Criterion 2: What Are the Broader Impacts of the Proposed Activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of under represented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Investigators preparing proposals to the NSF should consider both criteria and provide information in the proposal which will assist reviewers and NSF in evaluating the project against these criteria. Additional areas of interest to NSF are the extent that the project integrates research with education and the ability for the project to address NSF's need to include all citizens in funding activities.

-- Sally Eckert-Tilotta, Associate Director of Research and Program Development.

RESEARCH, GRANT OPPORTUNITIES LISTED

Following are research and grant opportunities. For more information, contact the Office of Research and Program Development at 777-4278.

U.S. GEOLOGICAL SURVEY

The purpose of the Species at Risk Program (SAR) is to fund short-term research and assessment projects to generate information that allows development of conservation agreements, action plans, and management alternatives that provide for the protection of flora and fauna and their habitats and thereby reduce the need for listing species as threatened or endangered. The initiative provides an opportunity for scientists to participate through survey and research activities. Projects are specifically intended to be of short duration and should seek to optimize partnerships with Federal agencies, states, universities, and the private sector. Successful SAR projects are often conducted by investigators who have identified key, small but critical gaps in our biological knowledge. Projects must be new, self-contained work designated to be completed, including the final report, within 18 months. Total funding anticipated for the fiscal year is approximately \$370,000. Funding is contingent on a Fiscal Year 2000 appropriation. Pre-proposals are required; selected investigators will be asked to prepare full proposals for technical review. Deadline: 11/1/99. Contact: Al Sherk, Species at Risk Program, Al_Sherk@usgs.gov, or 703-648-4076.

The Educational Component of the National Cooperative Geologic Mapping Program provides support to master's, doctoral, and eligible undergraduate students to generate geologic maps from field-based academic research programs. Objectives are to: 1) expand the research and educational capacity of academic programs that teach earth science students the techniques of geologic mapping and field data analysis, and 2) facilitate the publication and distribution of geologic maps generated from field studies. Implementation is by cooperative agreement. One agreement is allowed per institution, but the agreement can contain several projects. A 1:1 match is required for all projects. More information on this program is available at <http://www.usgs.gov/contracts> or by contacting ORPD. Because of the limited number of agreements, interested faculty should contact ORPD before preparing a proposal. Deadline: 12/2/99. Contact: Clementine Caudle-Wright, 703/648-7483, ccaudle@usgs.gov.

DEPARTMENT OF AGRICULTURE (USDA)

Support is available for scientific conferences, fellowships, or research grants focusing on two areas. Proposals on understanding forces affecting rural areas should: identify and measure the impacts of specific and definable global, national, and regional forces, including government policies, on rural families, communities, and small towns; interpret these forces in terms of changing or creating new policies and programs, or implementing new approaches to rural development programs to enhance the quality of life and economic viability of rural people; and understand quality of life aspects important to and resulting from living and working in rural areas and, using quantitative and qualitative techniques, analyze the interplay between rural development and the quality of life of rural people. Proposals on designing and evaluating new approaches to rural development are empirical studies of processes and activities at the level of families, communities, small towns, and local or State governments, including sub-State and multi-State entities, to: create and evaluate new programs and policies for improving the social vitality and economic strength of rural people and places; or evaluate ongoing rural development programs and initiatives. Proposals are invited from any social or behavioral science discipline or combination thereof. New and innovative theoretical perspectives and methodologies are encouraged. A limited number of Conference Grants--Rural Development will be considered for partial or, if modest, total support. Research may be performed by individual investigators, co investigators within the same discipline, or multidisciplinary teams. Fellowships--Rural Development provide \$90,000 for 2 years of support to investigators, who have or will soon receive their doctoral degree, in research on understanding forces affecting rural areas and for designing new approaches to rural development. Applicants must be U.S. citizens and have received their doctoral degree after 1/1/97 and no later than 7/31/00. Research Grants--Rural Development provide up to 5 years' support to individual investigators, co-investigators within the same discipline, or multidisciplinary teams. Deadline: 12/15/99. Contact: 202/401-5048; psb@reeusda.gov; <http://www.reeusda.gov/nri>.

INTERNATIONAL RESEARCH AND EXCHANGES BOARD (IREX)

The goal of the Sustaining Partnerships into the Next Century (SPAN) program is to strengthen and expand existing partnerships between U.S. and Russian organizations. Current, Round IV, sectors are: Civil Society, Rule of Law, Environment, Health, Business Development, and Social Sector Support. The program funds small, targeted and innovative activities that can best contribute to the achievement of one of more of the following objectives: accelerated development and growth of private enterprises; increased economic infrastructure to support market oriented growth; increased environmental management capacity to support sustainable economic growth; increased, better-informed citizens' participation in political and economic decision making; strengthened rule of law and respect for human rights; and improved effectiveness of selected social benefits and services. Applicants may request up to \$180,000 in United States Agency for International Development (USAID) funding for projects up to 20 months duration. Deadline: 11/1/99. Contact: Sara Van Gunst, svangunst@irex.org; www.irex.org (U.S.); www.irex.ru (Russia).

MCKNIGHT ENDOWMENT FUND FOR NEUROSCIENCE

Technological Innovations in Neuroscience Awards provide \$100,000 annually for 2 years as seed funding for highly innovative projects. The fund seeks to stimulate development of novel approaches to exploring and understanding how the brain functions. It is especially interested in catalyzing new ways to image brain functions and monitor and manipulate gene expression in developing and functioning brain. Examples of projects include: monitoring brain activity in awake, behaving animals; increasing spatial and temporal resolution of brain imaging methods; simultaneously measuring activity of ensembles of neurons; monitoring synaptic plasticity in developing and living organisms; delineating changing patterns of gene expression; developing analytical techniques for multichannel neuronal recording; and introducing genes and controlling gene expression in specific classes of neurons. Interested investigators should submit a 2-page letter of intent summarizing the project and indicating how an award would accelerate it. Multidisciplinary collaborations are encouraged. Contact: McKnight Technological Innovations in Neuroscience Award, McKnight Endowment Fund for Neuroscience, 600 TCF Tower, 121 S. 8th St., Minneapolis, MN 55402. Deadline: 12/1/1999.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

Research Opportunities in Space Life Sciences: Biomedical Research and Countermeasures Program (NRA-99-HEDS-03). Proposals may be for ground-based research investigations or space-flight experiments designed for Shuttle middeck or the early phase of utilization of the International Space Station. Research emphases include: Physiology, Behavior and Performance, Environmental Health Research, Clinical Research in Support of Space Missions, and Radiation Health Research. The solicitation is available electronically at http://peer1.idi.usra.edu/peer_review/nra/99_HEDS_03.html. Paper copies are available by calling 202/358-4180 and leaving a voice mail message. Deadlines: 10/15/99 (Letter of Intent); 12/1/99 (Proposal). Contact: NASA Headquarters, Code UL, Life Sciences Division, Washington, DC 20546, ATTN: Dr. David Tomko.

NATIONAL INSTITUTES OF HEALTH (NIH)

The objective of the Role of the Environment in Parkinson's Disease (RFA: ES-00-002) program is to stimulate research on the relative roles of environmental, endogenous neurochemical and modifying genetic factors in the cause of Parkinson's disease. A broad range of projects are appropriate, including (but not limited to) epidemiological studies, development of biomarkers, model development, and studies of the cellular and molecular effect of environmental toxins. Collaborations between basic, clinical neuroscientists, and neurotoxicologists and/or interdisciplinary in nature are especially encouraged. The total estimated funds available for support of research project grant (R01, R21) awards is \$4,000,000/year. Deadlines: 11/5/99 (Letter of Intent), 1/11/00 (Proposal). Contact: Annette G. Kirshner, National Institute of Environmental Health Science, 919/541-0488, kirshner@niehs.nih.gov; Eugene J. Oliver, National Institute of Neurological Disorders and Stroke, 301/496-5680, eol1c@nih.gov.

NATIONAL SCIENCE FOUNDATION (NSF)

The Action Agenda for Engineering Curriculum Innovation ("Action Agenda") Program is intended to be a catalyst in facilitating the exploration of innovations that improve the quality of engineering education for the next century. Proposals must be original, highly focused, and hold the promise of producing a lasting and widespread impact. To enhance the prospect of such an impact, an education impact plan is required of each proposal. The following areas of need are examples of particularly good opportunities for curriculum innovation: exposing all engineering students to several major technology tracts; curricula for emerging areas of engineering; and structured early career support. Approximately \$5.0 million will be available for about 10 awards in FY 2000. The program announcement can be downloaded at NSF's website at <http://www.nsf.gov/pubs/1999/nsf99169/nsf99169.txt>. Deadline: 1/31/00. Contact: Ernest Smerdon, 703/306-1380; esmerdon@nsf.gov.

The Information Technology Research (LTR) Program requests proposals for fundamental research in information technology, in particular research spanning information technology and scientific applications, and in the area of social, ethical and workforce issues. The purpose is to augment the knowledge base and workforce needed to enhance the value of information technology for everyone. Proposals must approach research activities in innovative ways rather than suggesting routine applications of existing technology. NSF encourages projects that integrate across the following categories: software,

information technology education and workforce, human-computer interface, information management, advanced computational science, scalable information infrastructure, social and economic implications of information technology, and revolutionary computing. Pending availability of funds, a separate solicitation will be issued for a terascale computer facility for high-end science and engineering. NSF anticipates funding for this program will be between \$35M-\$105M for FY 2000 to support standard grants, continuing grants, or cooperative agreements. Awards are expected to range from \$150K-\$3 million/year. Letters-of-intent are required. Projects requesting more than \$500K total must submit pre-proposals. Only proposals with budgets above \$500K total may request more than 3 years duration. Website for program announcement: <http://www.nsf.gov/pubs/1999/nsf99167/nsf99167.htm>. Deadlines: Budgets exceeding \$500K: 11/15/99 (Letter of Intent), 1/5/00 (Pre-proposal), 4/17/00 (Proposal); Budgets under \$500K: 1/5/00 (Letter of Intent), 2/14/00 (Proposal). Contact: William Bainbridge, Social, Behavioral and Economic Sciences (SBE), 703/306-1741, wbainbri@nsf.gov; John Cherniavsky, Education and Human Resources (EHR), 703/306-1650, jchernia@nsf.gov; Alan Gaines, Geosciences (GEO), 703/306-1517, againes@nsf.gov; Michael Lesk, Computer and Information Science and Engineering (CISE), 703/306-1930, mlesk@nsf.gov; Dennis Peacock, Office of Polar Programs (OPP), 703/306-1033, dpeacock@nsf.gov; Arthur Sanderson, Engineering (ENG), 703/306-1339, asanders@nsf.gov; Barry Schneider, Mathematical and Physical Sciences, 703/306-1808, bschneid@nsf.gov; Gerald Selzer, Biological Sciences (BIO), 703/306-1469, gselzer@nsf.gov; Mark Suskin, Division of International Programs (INT), 703/306-1702, msuskin@nsf.gov.

The Child Learning and Development initiative aims to support studies that increase our understanding of cognitive, social, and biological processes related to children and adolescents' learning in formal and informal settings. Additional priorities are to support research on learning and development that: incorporates multidisciplinary, multi-method, microgenetic, and longitudinal approaches; develops new methods and theories; examines transfer of knowledge from one domain to another; assesses peer relations, family interactions, social identities, and motivation; examines the impact of family, school, and community resources; assesses adolescents' preparation for entry into the workforce; and investigates the role of demographic and cultural characteristics in children's learning and development. The results of this initiative will add to our basic knowledge of children's learning and development and, ultimately, will lead to better educated children and adolescents who grow up to take productive roles as workers and as citizens. Awards are anticipated for Research Grants, Workshops, and Conferences. Website for program announcement: <http://www.nsf.gov/pubs/1999/nsf9942/nsf9942.htm>. Deadlines: 1/15/00, 7/15/00. Contact: Diane Scott-Jones, 703/306-1361, dscott@nsf.gov.

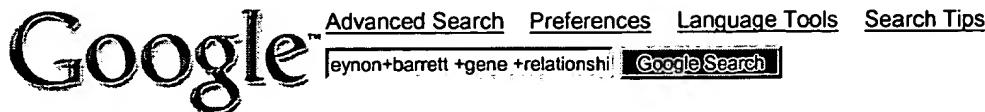
-- Sally Eckert-Tilotta, Associate Director, Office of Research and Program Development.

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All articles submitted for publication should be labeled "University Letter" and must reach the editor by 1 p.m. Tuesday. Electronic submissions may be sent to jan_orvik@mail.und.nodak.edu. Attachments to University Letter require approval of the editor and an account number. University Letter is issued by the UND Office of University Relations, Jan Orvik, editor, Box 7144, 411 Twamley Hall, 777-2731.

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... [Abstract/Free Full Text]; **Eynon**, EE, and Parker ... Herpesvirus Reveals a Close Similarity in **Gene** Sequence and ... K. Gouveia, BT Hovey Nerenberg, J. **Barrett**, L. Thomas ...
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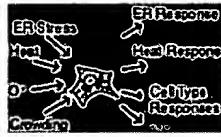
Stanford Microarray Database

SMD stores raw and normalized data from microarray experiments, as well as their corresponding image files. In addition, SMD provides interfaces for data retrieval, analysis and visualization. Data is released to the public at the researcher's discretion or upon publication

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Items of Interest

 [Extensive Association of Functionally and Cytotopically Related mRNAs with Puf Family RNA-Binding Proteins in Yeast Gerber et. al. PLOS Biology, 2\(3\)\(2004\) DOI: 10.1371/journal.pbio.0020079](#)



[Diverse and specific gene expression responses to stresses in cultured human cells. Murray JI, et al. \(2004\) Mol Biol Cell \(\)](#)

 [Cancer Characterization and Feature Set Extraction by Discriminative Margin Clustering Mungala, Tibshirani and Brown \(2004\). BMC Bioinformatics 5:21](#)

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[Universal Reference RNA as a standard for microarray experiments. Novoradovskaya et. al. BMC Genomics 2004, 5:20](#)



[The Vibrio cholerae chitin utilization program. Meibom KL, et al. \(2004\). Proc Natl Acad Sci U S A 101\(8\):2524-9](#)



[Role of interleukin 6 in myocardial dysfunction of meningococcal septic shock. Pathan N, et al. \(2004\) Lancet 363 \(9404\):203-9](#)

SMD Access: Access to non-public data is limited to registered Stanford researchers and their collaborators. Please see [SMD Registration](#) for more specific information. If you have further questions regarding access, please e-mail the Stanford Microarray Database curators at array@genome.stanford.edu.

Project Funding: The National Cancer Institute at the US National Institutes of Health, the National Science Foundation, and the Howard Hughes Medical Institute fund the Microarray Database. The database is a joint project in the Departments of [Biochemistry](#) and [Genetics](#) at the [School of Medicine](#), [Stanford University](#).

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Stanford Genomic Resources

This page provides links to various systematic analysis projects, resources, laboratories, and departments at Stanford University. It is maintained by the Saccharomyces Genome Database within the Department of Genetics.

Database Resources



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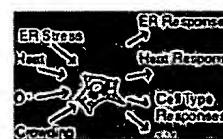
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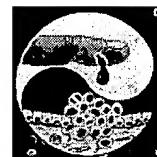
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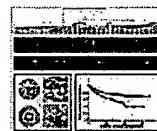
Murray JI, et al.
(2004) Diverse and specific gene expression responses to stresses in cultured human cells. *Mol Biol Cell* ()



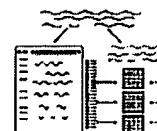
Chang HY, et al.
(2004) Gene Expression Signature of Fibroblast Serum Response Predicts Human Cancer Progression: Similarities between Tumors and Wounds. *PLoS Biol* 2(2):E7



Bergmann S, et al.
(2003) Similarities and Differences in Genome-Wide Expression Data of Six Organisms. *PLoS Biol* 2(1):E9



Lapointe J, et al.
(2004) Gene expression profiling identifies clinically relevant subtypes of prostate cancer. *Proc Natl Acad Sci U S A* 101(3):811-6



Hurowitz EH and Brown PO (2003) Genome-wide analysis of mRNA lengths in *Saccharomyces cerevisiae*. *Genome Biol*

5(1):R2

Shakoury-Elizeh
M, et al. (2004)
Transcriptional
Remodeling in
Response to Iron
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Saccharomyces
cerevisiae. Mol
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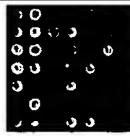
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DNA Microarray (Genome Chip)

-- Monitoring the Genome on a Chip

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Welcome to the DNA Microarray (Genome Chip) Web site! This simple, printer-friendly site has been created and maintained by Leming Shi, Ph.D. You'll find the basics on DNA microarray technology and a list of academic and industrial links related to this exciting new technology. Your comments, corrections, and suggestions are welcome. Please help me make this site more useful to you and many other visitors.

Last updated on January 7, 2002. CreditDisclaimerWarning: This Web site has NO association with Affymetrix, Inc. or its GeneChip® arrays.

This site was featured in Science magazine, ScienceGenomics.org, BioMedNet, etc.

<u>Concept</u>	<u>Design</u>	<u>Applications</u>	<u>Articles</u>	<u>Academic</u>	<u>Industry</u>	<u>Data Mining</u>
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DNA Microarray - A technology that is reshaping molecular biology

It is widely believed that thousands of genes and their products (i.e., RNA and proteins) in a given living organism function in a complicated and orchestrated way that creates the mystery of life. However, traditional methods in molecular biology generally work on a "one gene in one experiment" basis, which means that the throughput is very limited and the "whole picture" of gene function is hard to obtain. In the past several years, a new technology, called DNA microarray, has attracted tremendous interests among biologists. This technology promises to monitor the whole genome on a single chip so that researchers can have a better picture of the interactions among thousands of genes simultaneously.

Terminologies that have been used in the literature to describe this technology include, but not limited to: biochip, DNA chip, DNA microarray, and gene array. Affymetrix, Inc. owns a registered trademark, GeneChip®, which refers to its high density, oligonucleotide-based DNA arrays. However, in some articles appeared in professional journals, popular magazines, and the WWW the term "gene chip(s)" has been used as a general terminology that refers to the microarray technology. Affymetrix strongly opposes such usage of the term "gene chip(s)". More recently, I prefer the term "genome chip", indicating that this technology is meant to monitor the whole genome on a single chip. GenomeChip would also include the increasingly important and feasible protein chip technology.

Base-pairing (i.e., A-T and G-C for DNA; A-U and G-C for RNA) or hybridization is the underlining principle of DNA microarray.

An array is an orderly arrangement of samples. It provides a medium for matching known and unknown DNA samples based on base-pairing rules and automating the process of identifying the unknowns. An array experiment can make use of common assay systems such as microplates or standard blotting membranes, and can be created by hand or make use of robotics to deposit the sample. In general, arrays are described as *macroarrays* or *microarrays*, the difference being the size of the sample spots. Macroarrays contain sample spot sizes of about 300 microns or larger and can be easily imaged by existing gel and blot scanners. The sample spot sizes in microarray are typically less than 200 microns in diameter and these arrays usually contains thousands of spots. Microarrays require specialized robotics and imaging equipment that generally are not commercially available as a complete system.

DNA microarray, or DNA chips are fabricated by high-speed robotics, generally on glass but sometimes on nylon substrates, for which probes* with known identity are used to determine complementary binding, thus allowing massively parallel gene expression and gene discovery studies. An experiment with a single DNA chip can provide researchers information on thousands of genes simultaneously - a dramatic increase in throughput. (*Note: In the literature there exist at least two confusing nomenclature systems for referring to hybridization partners. Both use common terms: "probes" and "targets". According to the nomenclature recommended by B. Phimister of Nature Genetics, a "probe" is the tethered nucleic acid with known sequence, whereas a "target" is the free nucleic acid sample whose identity/abundance is being detected. This site follows that recommendation. See Nature Genetics volume 21 supplement pp 1 - 60, 1999, which is freely accessible.

There are two major application forms for the DNA microarray technology: 1) Identification of sequence (gene / gene mutation); and 2) Determination of expression level (abundance) of genes.

There are two variants* of the DNA microarray technology, in terms of the property of arrayed DNA sequence with known identity:

Format I: probe cDNA (500~5,000 bases long) is immobilized to a solid surface such as glass using robot spotting and exposed to a set of targets either separately or in a mixture. This method, "traditionally" called DNA microarray, is widely considered as developed at Stanford University. A recent article by R. Ekins and F.W. Chu (*Microarrays: their origins and applications. Trends in Biotechnology*, 1999, 17, 217-218) seems to provide some generally forgotten facts.

Format II: an array of oligonucleotide (20–80-mer oligos) or peptide nucleic acid (PNA) probes is synthesized either *in situ* (on-chip) or by conventional synthesis followed by on-chip immobilization. The array is exposed to labeled sample DNA, hybridized, and the identity/abundance of complementary sequences are determined. This method, "historically" called DNA chips, was developed at Affymetrix, Inc., which sells its photolithographically fabricated products under the GeneChip® trademark. Many companies are manufacturing oligonucleotide based chips using alternative in-situ synthesis or deposition technologies.

In the preparation of this Web site, "DNA microarray(s)" and "DNA chip(s)" are used interchangeably. But viewers should aware this technical difference.

* In addition, microfluidics-based chip or laboratory-on-a-chip systems are also listed in this Web site.

The microarray (DNA chip) technology is having a significant impact on genomics study. Many fields, including drug discovery and toxicological research, will certainly benefit from the use of DNA microarray technology. View an example of the microarray image (38K).

For a very well-written introduction on the steps involved in a microarray experiment, visit Jeremy Buhler's Anatomy of a Comparative Gene Expression Study

An excellent collection of Genomics Glossaries (including a Microarrays Glossary) is being maintained by Mary Chitty of Cambridge Healthtech Institute.

Design of a DNA Microarray System

There are several steps in the design and implementation of a DNA microarray experiment. Many strategies have been investigated at each of these steps. 1) DNA types; 2) Chip fabrication; 3) Sample preparation; 4) Assay; 5) Readout; and 6) Software (informatics)

Table 1. Steps in the design and implementation of a DNA microarray experiment

1) Probe (cDNA/oligo with known identity)	2) Chip fabrication (Putting probes on the chip)	3) Target (fluorescently labeled sample)	4) Assay	5) Readout	6) Informatics
Small oligos, cDNAs, chromosome, ... (whole organism on a chip?)	Photolithography, pipette, drop-touch, piezoelectric (ink-jet), electric, ...	RNA, (mRNA==>) cDNA	Hybridization, long, short, ligase, base addition, electric, MS, electrophoresis, fluorimetry, PCR-DIRECT, TaqMan, ...	Fluorescence, probeless (conductance, MS, electrophoresis), electronic, ...	Robotics control, Image processing, DBMS, WWW, bioinformatics, data mining and visualization

There are so many options and combinations, as can be seen from the number of companies involved in this business. It seems too early to judge who will be the winner(s) in this game. The forecast is further complicated by recent fights among companies on intellectual property issues.

Applications of DNA Microarray Technology

Gene discovery

(Many, many applications, to be listed)

Disease diagnosis

(Many, many applications, to be listed).

Many "microfluidics" devices (Chemical & Engineering News, February 22, 1999, 77(8):27-36; password required) fall in this category. Although they are not the "traditional" gene chip or microarray, I decided to list related links at this site because of their close connection and integration to the gene chip (microarray) technology.

Drug discovery: *Pharmacogenomics*

Why some drugs work better in some patients than in others? And why some drugs may even be highly toxic to certain patients? My favorite definition (modified): *Pharmacogenomics* is the hybridization of functional genomics and molecular pharmacology. The goal of pharmacogenomics is to find correlations between therapeutic responses to drugs and the genetic profiles of patients.

Toxicological research: *Toxicogenomics*

Have you seen anybody using this terminology? Now let's try to give it a definition: **Toxicogenomics** is the hybridization of functional genomics and molecular toxicology. The goal of toxicogenomics is to find correlations between toxic responses to toxicants and changes in the genetic profiles of the objects exposed to such toxicants. **First Preclinical Toxicity Application (Toxicology EXPRESS™ database using Gene Logic's Flow-thru Chip™ technology)** between Wyeth-Ayerst Research and **Gene Logic**

An interesting article: Nuwaysir, E.F., Bittner, M., Trent, J., Barrett, J.C., and Afshari, C.A. **Microarray and Toxicology: The Advent of Toxicogenomics.** *Molecular Carcinogenesis*, 24:153-159(1999).

NIEHS sponsored a meeting on the application of DNA microarray in toxicology (EHP 1999).

NIEHS established the National Center for Toxicogenomics (**NCT**) in June 2000.

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See also [Andreas Matern's home page on DNA Microarrays](#).

Academic Links

1. Many academic organizations have set up their microarray core facilities in order to make this technology accessible to their researchers. Dr. Wentian Li of Rockefeller University maintains a list of such core facilities.
2. DNA Microarray (Genome Chip) homepage (this site, created by Dr. Leming Shi), is a good starting point and contains a lot of useful links and background information. This site was reviewed by Science magazine.
3. *Science* magazine maintains an excellent collection of information on functional genomics. (www.sciencegenomics.org)
4. Dr. Ruth Alscher (ralscher@vt.edu) at Virginia Tech maintains an excellent Web site GRID IT on DNA Microarrays (<http://www.bsi.vt.edu/ralscher/gridit>).
5. Gene-Arrays mailing list (maintained by Chandi Griffin at San Francisco General Hospital/UCSF). To subscribe, send a one line e-mail message to listserv@listserv.ucsf.edu; the single line message should be: subscribe Gene-Arrays your-first-name your-last-name. This is a very good place to ask all kinds of questions regarding gene chips and DNA microarrays. To post a question to the whole mailing list, send email to <http://www.gene-chips.com/GENE-ARRAYS@ITSSRV1.UCSF.EDU>. You may

- leave the list at any time by sending a "SIGNOFF GENE-ARRAYS" command to [listserv@listserv.ucsf.eduFAQ in PDF](mailto:listserv@listserv.ucsf.edu)
- 6. [PlantArrays Mailing List](#) To subscribe send the word "subscribe" to mailto://plantarrays-request@genome.stanford.edu
 - 7. Tim Trnbarger maintains the [Plant-Array](#) Website in the context of the WWW Virtual Library (<http://www.w3.org/vl/>).
 - 8. A microarrays newsgroup was recently made available at <http://www.egroups.com/group/microarray/> (maintained by Philippe Marc).
 - 9. The Association of Biomolecular Resource Facilities (ABRF)'s Microarray Research Group (MARG) conducted a survey on the current status of the microarray technology. The results is presented in a poster: "THE STATE OF THE ART OF MICROARRAY ANALYSIS: A PROFILE OF MICROARRAY LABORATORIES."
 - 10. [The Microarray Site of Nature Genetics](#)
 - 11. Nobel Laureate Martin L. Perl's group at the [Stanford Linear Accelerator Center \(SLAC\)](#) is investigating if their new drop-on-demand inkjet technology originally designed for the searching of certain [hypothetical types of elementary particles](#) would be of use in the production of DNA microarrays.
 - 12. Stanford University's [Dr. Patrick Brown](#), one of the major players in this field. This group has a complete guide for researchers to [build their own microarrayer](#), at a fraction of the price of commercial products
 - 13. [DNA Microarray Protocols of Dr. Mark Schena](#): very detailed and useful information on performing DNA microarray experiments.
 - 14. [Dr. Mark Schena Home Page](#)
 - 15. [NIST ATP Awards 1998: Tools for DNA Diagnostics](#) (7 of the 29 proposals were awarded) Check project manager Dr. Stanley Abramowitz's [overview](#) talk on this field
 - 16. [CGAP](#) (Cancer Genome Anatomy Project) at the National Cancer Institute (NCI), NIH
 - 17. [Microarray Project](#) at the National Human Genome Research Institute (NHGRI), NIH
 - 18. [The NIEHS cDNA Microarray Center](#): Human ToxChip v 1.0, Human Discovery Chip, Yeast Chip, Rat Chip, Xenopus Chip v 1.0, and Mouse Chip.
 - 19. [Dr. John N. Weinstein](#) at the National Cancer Institute (NCI) developed an "information-intensive" anticancer drug discovery approach that integrates chemical structure information and anticancer activity patterns of >70,000 screened compounds with gene expression (microarray) data of the 60 human cancer cell lines
 - 20. [Dr. Alan Robinson's web resource on Gene Expression and Microarray Technologies](#), at EBI. (highly recommended) links to public sources of expression data, informatics, analysis tools, ...
 - 21. [Andreas Matern's home page on DNA Microarrays](#)
 - 22. [PhRMA's Microarrays and "DNA chips" site](#)
 - 23. [Anatomy of a Comparative Gene Expression Study](#) (by [Jeremy Buhle](#)). It's a very nice description of the microarray technology, also includes a [Glossary of Microarray-related Biotechnology Terms](#)
 - 24. [Whitehead Institute for Biomedical Research/MIT Center for Genome Research](#)
 - 25. [Dr. Geoffrey Childs, Functional Genomics at AECOM](#), Department of Molecular Genetics, Albert Einstein College of Medicine
 - 26. [Computational Genomics at Harvard University](#) (Dr. George M. Church, a lot of very useful links)
 - 27. [Human Genome Project Information at the Oak Ridge National Laboratory, U.S. Department of Energy](#)
 - 28. National Human Genome Research Institute (NHGRI) is developing "[Tissue Chip](#)" to Illuminate the Cancer Development Process. NIH Clinical Study: 97-C-0178: Fludarabine Treatment of Chronic Lymphocytic Leukemia: cDNA Microarray Gene Expression Analysis, and Preclinical Bone Marrow Transplant/Immunotherapy Studies
 - 29. [Garner Lab at UTSW - Gene Networks](#)
 - 30. [DNA Microarray Technology to identify genes controlling spermatogenesis](#), Sam Ward at the University of Arizona
 - 31. [Vivian Cheung's Lab at The Children's Hospital of Philadelphia](#) focuses on the development of Direct Identical-by-Descent (IBD) Mapping, which is a DNA microarray-based mapping technique that allows isolation and mapping of DNA fragments shared IBD between individuals.
 - 32. University of Washington, [Dr. Lee Hood](#), [Java-based Array Image Spot Finding and Quantification Software \(CrazyQuant\)](#)
 - 33. [Dr. Bernd Weisshaar's listing of DNA microarray links \(plants\)](#), [Max-Planck-Institut für Züchtungsforschung](#)
 - 34. [Dr. Landers' Group](#) at the University of Pittsburgh is developing microcolumn technology for clinical diagnostics. This capillary-based Integrated Diagnostic (ID) Chip may have great potential in clinical diagnostics.
 - 35. [Dr. Claude Jacq's group](#) at ENS, France. They also maintain a [discussion list](#): pucesadn@ens.fr
 - 36. [Toxicogenomics](#) homepage at the [Chemical Industry Institute of Toxicology \(CIIT\)](#): discusses how the DNA microarray technology is impacting toxicological research.
 - 37. Dr. Kent Vrana's [Gene Expression Technology](#) Group at the Wake Forest University School of Medicine.
 - 38. The Vanderbilt University [Microarray Core Facility \(microarrays.com\)](#) offers microarray-based products and services.
 - 39. [MRC Toxicology Unit DNA Microarray Pages](#) maintained by Dr Timothy W. Gant.
 - 40. The [Nylon MicroArrays](#) site provides detailed information on the use of nylon microarrays (allowing expression profiling with small amounts of unamplified RNA) and a number of useful utilities for choosing and checking IMAGE clones representing given genes. contact: jordan@ciml.univ-mrs.fr
 - 41. [Arabidopsis Functional Genomics Consortium \(AFGC\)](#) at Stanford University, funded by [NSF](#): microarrays, knockouts, and plant-specific genes.
 - 42. [Dr. Eiichiro Ichiiishi](#) of Kyoto Prefectural Univ. of Medicine maintains a Web site on DNA chip technology (in Japanese).
 - 43. [Dr. Michael C. Pirring](#) at Duke University is developing novel methods to cleave DNA strands into the shorter fragments for DNA chip analysis and [DNA chip computation](#).
 - 44. [ArrayNL platform](#)©: DNA-chips and microarrays in the Netherlands, maintained at the Department of Human and Clinical Genetics,

- Leiden University Medical Center.
45. [The Microarray Centre at The Ontario Cancer Institute](#).
 46. [Links to DNA Microarray protocols](#), maintained by Longcheng Li at UCSF
 47. [Biochip Research & Development Center](#), Tsinghua University, Beijing, China. Director: [Dr. Jing Cheng](#).
 48. [Natl. Lab. of Molecular and Biomolecular Electronics](#), Southeast Univ., Nanjing, China.
 49. [Zicai Liang at Karolinska Institutet](#).
 50. [KIChip](#): Karolinska Institute cDNA Micro-Array Core Facility
 51. Dr. Gerhard M. Kreshach maintains a list of more than 1000 links to Life Science News, Resources & Databases, including [DNA, Oligonucleotide, and Protein Arrays](#)
 52. [Fission yeast functional genomics group](#) at The Sanger Centre headed by Dr. Jurg Bahler.
 53. [The Xenopus Microarray Project](#) at Rockefeller Univ., includes protocols, software, and links.
 54. [The U.S. Environmental Protection Agency Microarray Consortium \(EPAMAC\)](#) (Great!)
 55. [The Center for Bioelectronics, Biosensors and Biochips](#) at Virginia Commonwealth University and the Medical College of Virginia Health System focuses on next generation microarrays, integrated molecular electronic devices using biologically active molecules and neurochips.
 56. St. George's Hospital Medical School's microarray facility on [Bacterial Microarrays](#).
 57. [UCLA Human Genetics DNA Microarray Core Facility](#)
 58. [Cornell Weill Medical College DNA Microarray Core Facility](#) (Dr. Jenny Z. Xiang)
 59. [Baylor College of Medicine Microarray Core Facility](#)
 60. [ORNL's Links to the Genetic World](#)
 61. [Scottish Centre for Genomic Technology and Informatics](#), Scotland University of Edinburgh.
 62. Prof. [Andreas Manz](#) of the Imperial College, UK, developed a novel concept for Miniaturized Total Analysis Systems (u-TAS): sampling, any sample pretreatment, separation, and detection steps are all performed in an integrated microsystem.
 63. Dr. [Michael Weller](#)'s group works on protein chips.
 64. Prof. [Dave Stahl](#)'s group at the Univ. of Washington is working on the [Phylochip](#) project: developing 16S rRNA-based microchips for determinative, phylogenetic and environmental studies.

Industry Links (Companies are listed alphabetically.)

A good summary of available [Human arrays](#) can be found at the September 4, 2000 issue of *The Scientist*. (by Jorge D. Cortese)

1. [ACLARA BioSciences, Inc.](#), (used to be called Soane Biosciences) Hayward, California (Plastic chips and microfluidic systems based on "Lab-On-A-Chip" microfluidics US Patent 5,750,015: "Method and device for moving molecules by the application of a plurality of electrical fields") Wins NIST ATP Award in "Tools for DNA Diagnostics" for Project: [Multiplexed Sample Preparation Microsystem for DNA Diagnostics](#)
2. [Advanced Array Technology S.A.](#) (Belgium), [BIO-CD™](#): compact disc platform for DNA detection
3. [Affymetrix, Inc.](#), Santa Clara, California (The technology leader; manufactures the widely used [GeneChip® arrays](#), including HIV, p450, p53, Rat Toxicology U34 arrays, etc.)
4. [Agilent Technologies, Inc.](#) (Palo Alto, California), a subsidiary of Hewlett-Packard Company, plans to expand its presence in the life science market through the introduction of a new DNA microarray program. It uses inkjet printing technology to manufacture its oligo-based DNA microarrays. Licensed from Ed Southern/OGT. LabChip™-based DNA and RNA bioanalyzer.
5. [Alexion Pharmaceuticals Inc.](#), New Haven, Connecticut
6. [Alpha Innotech Corp.](#), San Leandro, CA. Alpha Innotech provides innovation bioinformatic imaging solutions for genetic discovery designed to acquire, manage, and analyze fluorescence, chemiluminescence, or colorimetric microarray slides, plates, gels, blots, or films.
7. [AlphaGene, Inc.](#), Woburn, Massachusetts (full length cDNA FLEX™ and MicroFLEX library construction; High Throughput Gene Expression Profiling; High Throughput DNA Sequencing; Bioinformatics)
8. [Applied Precision, Inc.](#), Issaquah, Washington. ArrayWoRx is a wide field light source based microarray scanner, combines limitless wavelength possibilities with automation and image processing software.
9. [Asper Ltd.](#), Estonia. Arrayed Primer Extension (APEX) and Asper [ChipReader 003](#)
10. [AVIVA Biosciences Corp.](#), San Diego, CA. Dedicated to the application of breakthrough multiple-force biochip technology for genomics and proteomics. The company is developing an integrated sample-to-result AVIChip™ system with an emphasis on biological sample preparation and chip-based molecular manipulation. The AVIChip™ system will separate and transport a variety of mRNA, or other molecules from crude biological samples and simultaneously perform a wide range of biological and biochemical analyses. AVIVA's technology allows fast, accurate, automated, and high-throughput biological analysis on integrated biochip systems and provides novel approaches to both drug development and clinical diagnostics.
11. [Axon Instruments, Inc.](#), Foster City, California ([GenePix 4000](#) Integrated Microarray Scanner and Analysis Software, simultaneously scans microarray slides at two wavelengths using a dual laser scanning system, displays images from two wavelengths and a ratio image as they are acquired in real time; US\$50,000)
12. [AxyS Pharmaceuticals](#), La Jolla, California: Wins NIST ATP Award in "Tools for DNA Diagnostics" Project: [Liquid Array Technology Development](#)
13. Beckman-Coulter

14. Beecher Instruments, Silver Spring, MD. Tissue array technology for high-throughput analysis of tissue specimens.
15. BioArray Solutions, LLC, Piscataway, NJ. Light-controlled Electrokinetic Assembly of Particles near Surfaces (LEAPS), enables computer controlled assembly of beads and cells into planar arrays within a miniaturized, enclosed fluid compartment on the surface of a semiconductor wafer.
16. BioChip Technologies
17. bioDevice Partners, Cohasset, MA. Provides consulting services to the microarraying community in the area of optics and instrumentation
18. BioDiscovery, Inc., Los Angeles, California (ImaGene™, special image processing and data extraction software; CloneTracker: Databases clones, plates, and slides, and offers array design tool and interfaces to arrayers; GeneSight: Powerful expression analysis software which features statistical methods as well a visualization tools.
19. Biodot
20. Biomedical Photometrics, Inc., (MACROscope™ for reading genetic microarrays, in collaboration with Canadian Genetic Microarray Consortium)
21. bioMerieux, in vitro diagnostics
22. BioRobotics Ltd., Comberton, Cambridge, UK (MicroGrid, for arraying oligonucleotides or cDNA clones on glass slides and plastic chips)
23. Brax, Cambridge, UK
24. Cadus Pharmaceutical Corp., Tarrytown, New York (yeast living chip)
25. Caliper Technologies Corp., Palo Alto, California: LabChips™ based on microfluidics. Awarded \$2 million contract by NIST to develop high-throughput DNA diagnostic platform. Project: Reference Laboratory LabChip™ DNA Diagnostics System
26. Capital Biochip Corp., Beijing, China. Co-founded on 30th September 2000 by Tsinghua University, Huazhong University of Science and Technology, Chinese Academy of Medical Sciences and Academy of Military Medical Sciences. The registered capital for Capital Biochip is RMB \$390 million with RMB \$240 million contributed by the four institutional founding members and RMB \$150 million from international venture capital firms. (Note: 1 US dollar = ~8.2 RMB). It is backed by funds from the Chinese governmental agencies to developed and commercialize various biochip technologies. It is recruiting qualified researchers from the world.
27. Cartesian Technologies, Inc., Irvine, CA. PixSys PA Series: for Automated liquid handling system for creating high-density arrays for genomics research. Scan Array 3000: A Fluorescent Imaging System for microarray biochips.
28. Celera, Rockville, Maryland (Everyone knows this company!)
29. Cellomics, Inc., Pittsburgh, Pennsylvania (ArrayScan™, cell-based "High Content Screening" (HCS) for drug discovery)
30. Cepheid Sunnyvale, California (microfluidics)
31. Clinical Micro Sensors, Inc., Pasadena, California. Now part of Motorola. DNA microchip-based medical diagnostics; detection of directly detect DNA via electron transfer. Wins NIST ATP Award in "Tools for DNA Diagnostics" Project: DNA Diagnostics for the Point of Care Using Electronic Nucleic Acid Detection
32. Clondiag Chip Technologies, Jena, Germany. Working on generation and application of DNA microarrays. Current products: Ikonoclast (imaging tool), Partisan ArrayLIMS (LIMS for bioarrays).
33. Clontech's Atlas™ human cDNA array (nylon-membrane based)
34. CombiMatrix Corporation, Burlingame, CA.
35. Compugen's LEADS™ drug discovery platform for identifying drug targets based on the analysis of EST (Expressed Sequence Tag) and genomic databases, expression results from chips and proteomics, and polymorphism detection and qualification; DNA chip design and analysis. LabOnWeb.com
36. Corning Science Products Division, Acton, MA provides the (Corning Microarray Technology) CMT-GAPS amino silane coated slides and CMT-Hybridization chamber.
37. Corvas International, Inc., (2D gel, proteomics)
38. Cruachem Ltd, U.K. manufactures the phosphoramidite building blocks for the synthesis of DNA. Its expertise in DNA technology provides an efficient service for the supply of DNA oligonucleotides. Cruachem Ltd is enthusiastically looking for partners with which to collaborate in the area of DNA chip technology.
39. CuraGen Corp., New Haven, Connecticut. GeneCalling™ and Quantitative Expression Analysis (QEATM), CuraMode, CuraTox
40. diaDexus, LLC, Santa Clara, California. joint venture between SmithKline Beecham Corp. and Incyte Pharmaceuticals, Inc.. Specialized in using microarray technology for molecular diagnostics
41. Display Systems Biotech, Inc., Vista, CA and Copenhagen, Denmark. discoveryARRAY slides (over 2400 expressed cDNA fragments); will soon offer over 40,000 arrayed mouse and human genes; GEE-NOME Bioinformatic system.
42. DNAmicroarray.com, offers complete "made to order" high density DNA microarray synthesis and analysis services. Prices, availability, and turnaround time seem impressive.
43. Erie Scientific Company, Portsmouth, NH, manufactures microslides for microarrays.
44. Eurogentec, Seraing, Belgium. Sells yeast and Bacillus subtilis genomic membranes.
45. Expression Analysis Inc., RTP, NC., was formed to provide GeneChip processing and gene expression analysis using Affymetrix GeneChip microarrays.
46. Gel biochip
47. First Genetic Trust, Inc., Deerfield, IL. Acting as a third-party intermediary among researchers, health care providers and patients. Its goal is to build a comprehensive, high-security, independent "genetic bank".

48. Gene Logic, Inc., Columbia, Maryland (Flow-thru ChipTM). has hundreds of thousands of discrete microscopic channels that pass completely through it. Probe molecules are attached to the inner surface of these channels, and target molecules flow through the channels, coming into close proximity to the probes. This proximity facilitates hybridization. READSTM, Restriction Enzyme Analysis of Differentially-expressed Sequences, for capturing and analyzing the overall gene expression profile of a given cell or tissue type to identify drug targets).
49. Geneka Biotechnology Inc., Montreal, Canada. Oligonucleotide-based microarray slide, the P.R.O.M. (Proteomic Regulatory Oligonucleotide Microarray). 35-45-mers.
50. Genemachines Genomic Instrumentation Services, Inc., Menlo Park, California (OmniGrid, glass slides or nylon membranes, similar to Dr. Pat Brown's)
51. General Scanning Inc., Watertown, Massachusetts (laser scanning and micropositioning, manufactures MicroArray Biochip Scanning System: ScanArrayTM). Now called GSI Lumonics
52. GeneScreen, Inc., The Genetics Profiling Company
53. Genisphere, Oakland, New Jersey. Provides fluorescently-labeled kits for gene expression arrays. (uses highly branched nucleic acids - dendrimer technology)
54. GeneTrace Systems
55. Genetic Analysis Technology Consortium (GATC)
56. Genetic MicroSystems Inc., Woburn, Massachusetts (instrumentation for DNA microarray-based analysis) Acquired by Affymetrix.
57. Genetix Ltd., Christchurch, Dorset, UK (Q-Bot, Q-Pix)

- Genicon Sciences Corp, San Diego, CA. Developed an ultra-sensitive signal generation and detection platform technology based on Resonance Light Scattering (RLS) for the simple and efficient detection, measurement and analysis of biological interactions.
58. Genome Systems Inc., St. Louis, MO, a wholly owned subsidiary of Incyte Pharmaceuticals, Inc., GDA: Gene Discovery Array
 59. Genometrix Inc., The Woodlands, Texas (BioscannerTM, GeneView[®], Universal ArraysTM, Risk-Tox)
 60. Genomic Solutions, Ann Arbor, Michigan (FlexysTM modular robotic system, GeneTACTM and Genomic IntegratorTM array analysis products automates the imaging and analysis of gene microarrays.)
 61. GENPAK Inc., Stony Brook, NY. genpakARRAY 21 robotic microarrayer system and genSTATION 3XL manual microarrayer system.
 62. GENSET, Paris, France (specialized in pharmacogenomics)
 63. Genemed Synthesis Inc., South San Francisco, CA. Supplies oligos.
 64. GenomeWeb, print and electronic provider of news and information on the business and technology of genomics and bioinformatics worldwide.
 65. GeSiM, Germany. The Nano-Plotter is based on piezoelectric pipetting principle.
 66. Genzyme Molecular Oncology (SAGE[®]: Serial Analysis of Gene Expression)
 67. HP GeneArray Scanner (used by Affymetrix and others)
 68. Hypromatrix, Inc., Millbury, MA. Hypromatrix AntibodyArray TM is designed to detect protein-protein interactions, post-translational modification and protein expression.
 69. Hyseq Inc., Sunnyvale, California (Sequencing By Hybridization. HyX platform and Gene Discovery, HyGnostics, and HyChipTM modules)
 70. Illumina, Inc., San Diego, California. utilizes fiber optics, microfabrication, and advanced information processing to create arrays where 250,000 discrete sensors fit on a probe the diameter of the head of a pin.
 71. I.M.A.G.E. Consortium: "Sharing resources to achieve a common goal - the discovery of all genes"
 72. Incyte Genomics, Inc., Palo Alto, California (GEM Microarrays, GeneJetTM array, LifeSeq[®] Database with estimated 100,000 genes, and LifeArray Microarray Software)
 73. IntegriDerm, Inc., Huntsville, AL. Produces DermArray DNA microarrays for dermatologic research.
 74. Intelligent Bio-Instruments, Cambridge, Massachusetts
 75. JMAR's Precision Systems, Inc., Chatsworth, CA. Designer and manufacturer of UV exposure and mask aligner systems specifically designed for bio-chip manufacturers. Also produces custom micropositioning systems for micro-spotting equipment and high resolution dimensional metrology and defect inspection systems for quality assurance of bio-chips and DNA microarrays.
 76. Lab-on-a-Chip.com, provides focused information on all Lab-on-a-Chip technologies. It includes published papers, news, events, new products, suppliers, research links, jobs and discussion forums.
 77. Labman Automation Ltd., North Yorkshire, TS9 5JY, UK (HDMS: Labman High-Density Microarray Spotter)
 78. Lifecodes Corp., Stamford, Connecticut (Lifecodes MicroArray System: LMAS)
 79. Lynx , MegasortTM is a bead-based process providing differential DNA analysis.
 80. Medway SA, Mezzovico, Switzerland. MEDWAY designs, develops, manufactures and commercialises medical devices for diagnostics, robotic systems, optical instruments, fluorescent molecular markers, sieving microchips. Offers GMO testing.
 81. Mergen Ltd., San Leandro, CA. ExpressChipTM oligonucleotide microarray. Offers a full range of services.
 82. MetriGenix Inc., Gaithersburg, MD. The 4D Array utilizes a patented flow through design that optimizes the surface area to volume ratio, has shorter hybridization times, provides larger binding/signal capacity, and is more readily automated than flat biochips.
 83. Micralyne Inc., (formerly Alberta Microelectronic Corp.) Edmonton, Alberta, Canada. Fabricates micromachined glass, silicon and thin film components for use in microfluidics.

84. MicroFab Technologies, Inc., Plano, TX. manufactures piezoelectric drop-on-demand ink-jet printing technology for microdispensing fluids.
85. Micronics, Inc., Redmond, Washington. microfluidics based systems for application to clinical laboratory diagnostics: Microcytometer™, H-Filter™, T-Sensor™, and O.R.C.A. μFluidics.
86. Molecular Dynamics, Inc., Sunnyvale, California (Storm® and FluorImager®)
87. Molecular Tool, Inc., Baltimore, Maryland. Genetic Bit Analysis, GBA® Genomatic™. Acquired by Orchid Biocomputer on September 14, 1998.
88. Mosaic Technologies, Inc., Waltham, MA. EZ-RAYS™ activated slide kits for DNA microarrays.
89. Motorola BioChip Systems. Licensed a 3-D gel pad technology from Argonne National Laboratory.
90. Nanolytics is developing Custom Array Synthesis Technology
91. Nanogen, San Diego, California (Electronic Addressing, Concentration, and Hybridization)
92. NEN Life Science Products, Boston, MA (MICROMAX™ Human cDNA Microarray System I for differential gene expression analysis)
93. Oncormed Inc., (acquired by Gene Logic in July, 1998) characterizes genes to establish their clinical relevancy and provides molecular profiling of patients for pharmacogenomic and therapeutic purposes
94. Operon Technologies, Inc., Alameda, CA. Low density (320 or 370 genes, 70-mers) OpArrays™ microarrays.
95. Orchid BioSciences, Inc., Princeton, New Jersey (a Sarnoff company) microfluidic chips; applying microfabrication processes in glass, silicon, and other materials to create three dimensional structures. Contained within these devices are small capillary channels less than a millimeter wide. Wins NIST ATP Award in "Tools for DNA Diagnostics" Project: Polymerase Signaling Assay for DNA Variation Detection on Universal Processor Arrays It also has a Web site on single nucleotide polymorphisms (SNPs).
96. OriGene Technologies Inc., Rockville, MD. Offers SmartArray™ chips (Huamn), including nuclear hormone receptors, homeobox/b-zip/HLH transcription factors, tissue-specific/inducible transcription factors , and phosphotyrosine Kinases.
97. Oxford Gene Technology Ltd (Ed Southern) Oligo-based microarray
98. Packard Instrument Company, Meriden, Connecticut. (BioChip Arrayer)
99. PamGene B.V., The Netherlands. flow-through technology for microarray.
100. PE Applied Biosystems, Wins NIST ATP Award in "Tools for DNA Diagnostics" for project: Integrated, Micro-Sample Preparation System for Genetic Analysis
101. PharmaSeq, Inc., Monmouth Junction (near Princeton), NJ. Developer of microtransponder-based technology for DNA diagnostic assays. Wins NIST ATP Award in "Tools for DNA Diagnostics" for project: Multiplex DNA Diagnostic Assay Based on Microtransponders
102. Phase-1 Molecular Toxicology, Inc., Santa Fe, New Mexico. Molecular and high throughput toxicology using gene chips (Licensed from Xenometrix)
103. Proligo LLC, Boulder, CO. Nucleic acid supplier.
104. Protogene Laboratories, Palo Alto, California (Surface tension array on glass substrate; "Printing" reagents using drop-on-demand technology)
105. R&D Systems, Minneapolis, M. Cytokine Expression Array allows one to determine the RNA level for approximately 400 cytokines and related factors in one standard hybridization experiment. (charged nylon membrane)
106. Radius Biosciences, Medfield, Massachusetts. Custom DNA, RNA, PNA, and Protein MicroArray Chips.
107. RELAB AG, Germany, is developing BioChip arrays for diagnostic applications (oncology). The GeneStick platform with arrays on plastic sticks and a new chemiluminescence imager.
108. Research Genetics, Huntsville, Alabama (GeneFilter)
109. RoboDesign International Inc., Carlsbad, CA. Its RoboArrayer is integrated with a vision system to allow for real-time quantification of spot size and spot volume during the printing process.
110. Rosetta Inpharmatics, Kirkland, Washington. FlexJet™ DNA oligonucleotides microarrays (in-situ synthesized on a glass support via ink-jet printing process); Resolver™ Expression Data Analysis System.
111. SciMatrix, Inc., Durham, NC. Offers ArrayWorks™, a complete line of custom microarray services, for the production, processing, and analysis of microarrays, using PixSys™ arrayers from Cartesian Technologies. It also provides customized ArrayEngine™ microarray systems.
112. Sequana Therapeutics (merged with Arris Pharmaceutical to become AxyS Pharmaceuticals), La Jolla, California
113. Sequenom, Hamburg, Germany, and San Diego, California (DNA MassArray, BiomassPROBE, Biomass SIZE, BiomassSEQUENCE, BiomassSCAN, BiomassINDEX, and SpectroChip)
114. Sigma-Genosys Ltd., The Woodlands, Texas (Panorama™ E. coli Gene Arrays, 4,290 genes per array)
115. SuperArray Inc., Bethesda, MD. Their gene expression array (GEArray™) systems (Human and mouse) are designed for pathway-specific gene expression profiling. Also offers ChoiceGEArray to meet customer's specific requirements.
116. SurModics, Inc., Eden Prairie, Minnesota. Manufactures 3D-Link™ activated slides for the production of microarrays. Uses amine-modified DNA to hybridize on the surface of the slide.
117. Synteni, Inc., Fremont, California (acquired by Incyte Pharmaceuticals, Inc. in January 1998) (UniGEM™ Gene Expression Microarray)
118. The German Cancer Institute, Heidelberg, Germany

119. TeleChem International, Sunnyvale, California (offers whole system parts: ChipMaker, SmartChips, ArrayIt, Hybridization Cassette, ScanArray 3000, ImaGene Quantification Software, and Super Microarray Substrates)
120. Third Wave Technologies, Inc., Madison, WI. Develops and commercializes simple, low-cost nucleic acid platform technologies to fundamentally alter disease discovery, diagnosis and treatment. Invader® assay and CFLP® Technology
121. Tissue Array, for expression study of protein and in situ screening of mRNA.
122. V&P Scientific, Inc., San Diego, CA. Supplies inexpensive replicators (\$3000 or so) that will make macroarrays on membranes, or microarrays on slides.
123. Virtek Vision International Inc. (Ontario, Canada) ChipReader™ is a high-sensitivity laser confocal system for rapid imaging of the DNA microarrays.
124. Vysis, Inc., Downers Grove, Illinois (CGH-Comparative Genomic Hybridization; The GenoSensor Microarray System includes genomic microarrays, reagents, instrumentation and analysis software.)
125. Xanthon, Research Triangle Park, North Carolina, has developed a multiplexed, microplate-based electrochemical detection system for high-throughput screening of compounds for their effects on gene expression. Based on measurement of the oxidation of guanine on an electrode.
126. Xenometrix, Inc., Boulder, CO (Gene Profile Assay and bioinformatics for gene induction profile analysis; a demo is available)
127. XENOPORE Corp., Hawthorne, NJ. Manufacturer of coated microscope slides, including silanated, silylated, epoxy, streptavidin, nickel chelate, and many other surfaces.

Table 2. The main features of some hybridization microarray formats currently available*

Company	Product name	Arraying method	Hybridization step	Readout	Main focus
<u>Affymetrix, Inc.</u> , Santa Clara, California	<u>GeneChip®</u>	<i>In situ</i> (on-chip) photolithographic synthesis of ~20-25-mer oligos onto silicon wafers, which are diced into 1.25 cm ² or 5.25 cm ² chips	10,000-260,000 oligo features probed with labeled 30-40 nucleotide fragments of sample cDNA or antisense RNA	Fluorescence	Expression profiling, polymorphism analysis, and diagnostics
Brax, Cambridge, UK		Short synthetic oligo, synthesized off-chip	1000 oligos on a "universal chip" probed with tagged nucleic acid	Mass spectrometry	Diagnostics, expression profiling, novel gene identification
<u>Gene Logic, Inc.</u> , Columbia, Maryland	READS™				
<u>Genometrix Inc.</u> , The Woodlands, Texas	Universal Arrays™				
<u>GENSET</u> , Paris, France					
<u>Hyseq Inc.</u> , Sunnyvale, California	HyChip™	500-2000 nt DNA samples printed onto 0.6 cm ² (HyGnostics) or ~18 cm ² (Gene Discovery) membranes Fabricated 5-mer oligos printed as	64 sample cDNA spots probed with 8,000 7-mer oligos (HyGnostics) or <=55,000 sample cDNA spots probed with 300 7-mer oligo (Gene Discovery) Universal 1024	Radioisotope Fluorescence	Expression profiling, novel gene identification, and large-scale sequencing (Gene Discovery array), polymorphism analysis and diagnostics (HyGnostics/HyChip arrays), and large-sample sequencing (HyChip array)

		1,15 cm ² arrays onto glass (HyChip)	oligo spots probed 10 kb sample cDNAs, labeled 5-mer oligo, and ligase		
<u>Incyte Pharmaceuticals, Inc., Palo Alto, California</u>	GEM	Piezoelectric printing for spotting PCR fragments and on-chip synthesis of oligos	<=1000 (eventually 10,000) oligo/PCR fragment spots probed with labeled RNA	Fluorescence and radioisotope	Expression profiling, polymorphism analysis, and diagnostics
<u>Molecular Dynamics, Inc., Sunnyvale, California</u>	Storm® FluorImager®	500-5000 nt cDNAs printed by pen onto ~10 cm ² on glass slide	~10,000 cDNA spots probed with 200-400 nt labeled sample cDNAs	Fluorescence	Expression profiling and novel gene identification
<u>Nanogen, San Diego, California</u>	Semiconductor Microchip	Prefabricated ~20-mer oligos, captured onto electroactive spots on silicon wafers, which are diced into <=1 cm ² chips	25, 64, 400 (and eventually 10,000) oligo spots polarized to enhance hybridization to 200-400 nt labeled sample cDNAs	Fluorescence	Diagnostics and short tandem repeat identification
<u>Protogene Laboratories, Palo Alto, California</u>		On-chip synthesis of 40-50-mer oligos onto 9 cm ² glass chip via printing to a surface-tension array	<=8,000 oligo spots probed with 200-400 nt labeled sample nucleic acids	Fluorescence	Expression profiling and polymorphism analysis
<u>Sequenom, Hamburg, Germany, and San Diego, California</u>	MassArray SpectroChip	Off-set printing of array; around 20-25-mer oligos	250 locations per SpectroChip interrogated by laser desorption and mass spectrometry	Mass spectrometry	Novel gene identification, candidate gene validation, diagnostics, and mapping
<u>Synteni, Inc., Fremont, California (acquired by Incyte Pharmaceuticals, Inc.)</u>	UniGEM™	500-5,000 nt cDNAs printed by tip onto ~4 cm ² glass chip	<=10,000 cDNA spots probed with 200-400 nt labeled sample cDNAs	Fluorescence	Expression profiling and novel gene identification
The German Cancer Institute, Heidelberg, Germany		Prototypic PNA macrochip with on-chip synthesis of probes using f-moc or t-moc chemistry	Around 1,000 spots on a 8 x 12 cm chip	Fluorescence/mass spectrometry	Expression profiling and diagnostics

* to be updated... Modified from Marshall, A.; Hodgson, J. DNA chips - an array of possibilities. *Nature Biotechnology* 1998, 16(1), 27-31.

Data Mining: Making Sense of Gene Expression Data

Schema of Array Databases and On-line Tools:

1. A comprehensive list of gene expression database and analysis tools is available at NCGR's [GeneX](#) site.
2. Microarray Gene Expression Database ([MGED](#)) Group, was formed to facilitate the adoption of standards for DNA-array experiment annotation and data representation, as well as the introduction of standard experimental controls and data normalisation methods.
3. [Microarrays databases](#) on the WWW (by Bernard MARTIN and Philippe MARC)
4. NCBI's [Gene Expression Omnibus \(GEO\)](#) public gene expression repository in development - contact Alex Lash - lash@ncbi.nlm.nih.gov
5. [ArrayDB](#) (<http://genome.nhgri.nih.gov/arraydb/schema.html>) at the [National Human Genome Research Institute \(NHGRI\)](#)
6. [μArray Center](#) at the National Cancer Institute's is in the final stages of reviewing/implementing a complete, robust schema.
7. [expressDB](#) of George Church Lab's at Harvard Medical School: a relational database containing yeast RNA expression data. As of July, 1999 it contains 17.5 million pieces of information loaded from 11 published and in-house expression studies.
8. [MAT](#) (Microarray Analysis Tool) at Albert Einstein College of Medicine: based on Java, JDBC, and Sybase SQL.
9. [GATC](#) consortium's published [schema](#)
10. [GeneX](#): a Collaborative Internet Database and Toolset for Gene Expression Data at the [National Center for Genome Resources](#).
11. [GenEx™](#) of Silicon Genetics is a public web database that allows scientists to freely distribute and visualize gene expression data (text and image) from microarrays, Affymetrix chips, and related technologies. It can also dynamically generate several graphs from the data being viewed, such as: scatter plots, trees, overlays, ordered lists, line graphs, or physical position graphs. It is designed to store annotations and interpretations on finished experiments, and can access data from SQL databases like GATC or even from flat text files.
12. [Stanford MicroArray Database \(Oracle\)](#)
13. The Arabidopsis Functional Genomics Consortium (AFGC)'s [Arabidopsis cDNA Microarray Results](#)
14. [ArrayExpress](#), being developed at the European Bioinformatics Institute, will be a public array-based gene expression data repository. An international meeting on [Microarray Gene Expression Databases](#), November 14-15, 1999.
15. [Dr. John Weinstein](#)'s Genomics and Bioinformatics Group at the NCI has made some microarray data and tools available online.
16. [Michael Eisen](#)
17. [Dr. Peter Lemkin](#) at the NCI developed a Java applet, [MicroArray Explorer \(MAExplorer\)](#), which is currently being used in the [Mammary Genome Anatomy Program](#)
18. Dr. Leif Peterson's [CLUSFAVOR](#): Partitioning Large-sample Microarray-based Gene Expression Profiles Using Principal Components Analysis
19. [SAGEmap](#): A Public Gene Expression Resource, Alex E. Lash et al., *Genome Res.* 2000 July 1; 10(7): p. 1051-1060
20. [J-Express](#): Java program for analyzing microarray data. SOM and PCA implemented, by Bjarte Dysvik.
21. [MicroArray Informatics at the EBI](#)

"House Keeping Genes": <http://www.hugeindex.org/>; Khan et al, *Cancer Research* 58, Nov. 1998, p.5009-5013

Software Providers:

1. [Applied Maths](#), Belgium. [GenExplore™](#) : 2-way cluster analysis, principal component analysis, discriminant analysis, self-organizing maps.
2. [BioDiscovery, Inc.](#), Los Angeles, California ([ImaGene™](#), special image processing and data extraction software, powered by [MatLab®](#); [GeneSight](#): hierarchical clustering, artificial neural network (SOM?), principal component analysis, time series; [AutoGene™](#); [CloneTracker™](#))
3. [Cose](#), France. [XDotsReader](#) software
4. [GeneData AG](#) (Basel, Switzerland), analysis of genomics and proteomics data: [GeneData WorkBench](#), [GeneData Expressionist](#).
5. [Gene Network Inference from Large-Scale Gene Expression Data](#) (Patrik D'haeseleer, University of New Mexico).
6. [Gene Network Sciences](#), Ithaca, NY 14850. Accelerates the drug discovery process by creating dynamic computer models of living cells. BioMine for microarray data analysis.
7. [Molecular Pattern Recognition](#) web site at MIT's Whitehead Genome Center. Focuses on computational methodologies for the analysis and interpretation of large-scale expression data sets generated by DNA micro-array experiments.
8. [Imaging Research, Inc.](#), St. Catharines, Ontario, Canada. The company writes software, develops detection technologies, and integrates systems for image analysis. Its PC-based [ArrayVision™](#) system has been widely used for rapid and automated analysis of genome arrays.
9. [LION Bioscience AG](#)'s [arraySCOUT™](#) is a new software for analyzing gene expression data. [arraySCOUT™](#) is able to link all expression data to internal and external biological databases via SRS. This link provides information on the function, structure and metabolic pathways of genes from up to 400 databases. [arrayTAG](#) - cDNA collections specifically tailored to chip technology; [arrayBASE](#) - cDNA annotations in a comprehensive database.
10. [Molecular Applications Group](#), Palo Alto, CA. [Stingray™](#) is integrated software and database products for gene expression, gene function, and gene sequence analysis from microarray data. It is integrated with and dependent upon the use of Affymetrix's [GeneChip®](#) system and its Expression Data Mining Tool (EDMT) software. [Its ownership of and rights to [Stingray™](#) were sold to Affymetrix in December, 1999.] No longer a corporate entity.

11. MolecularWare, Inc.: ArrayAnalyzerDB
12. Partek, Inc., St. Peters, Missouri. Provider of pattern recognition and data visualization software for science and engineering. Its Partek Pro 2000 system has been used by companies to analyze microarray gene expression data.
13. Rosetta Inpharmatics, Kirkland, Washington. Resolver™ Expression Data Analysis System.
14. Scanalytics, Inc., Fairfax, VA. Its MicroArray Suite enables researchers to acquire, visualize, process, and analyze gene expression microarray data. Developed by scientists at the NIH's National Human Genome Research Institute.
15. Silicon Genetics' GeneSpring™ workbench for analyzing experiments based upon genomic expression experiments.
16. Spotfire, Inc., Cambridge, Massachusetts. Offers advanced data visualization capabilities including the ability to perform gene cluster analysis and metabolic pathway mapping. The Spotfire Array Explorer is particularly attractive to experimentalists performing microarray analysis.
17. Media Cybernetics, L.P., Silver Spring, MD: Array-Pro(R).
18. Microarray Software developed by Stanford University
19. Synomics Ltd., Cambridge, UK (bioinformatics)
20. TIGR (The Institute for Genome Research) offers software tools (free for academic institutions) for array analysis.
21. Dr. Terry Speed's Microarray Data Analysis Group Page: very good resource on statistics aspects of microarray data [Berkeley]
22. GCG's SeqArray Improves MicroArray Data Analysis, Visualization, and Management
23. Premier Biosoft International, Palo Alto, CA. Array Designer - designs PCR primers and oligonucleotide probes for microarrays
24. OmniViz, Inc., Columbus, OH, a subsidiary of Battelle. Provides information visualization and data mining solutions for life and chemical sciences. Product: OmniViz Pro
25. ViaLogy Corp., utilizes quantum interferometric computing to analyze biochips
26. Xpogen Inc., Cambridge, MA. Web-based tools for organizing, sharing, analyzing, and interpreting gene expression microarray data and associated annotation. "relevance networks".

Articles on Microarray Datamining:

Wentian Li of Rockefeller University maintains a list of papers on data analysis: <http://linkage.rockefeller.edu/wli/microarray/>

On-line Information

The International Society for Computational Biology (ISCB).

Plaid models for microarrays and DNA expression at Stanford University

Patrik D'haeseleer [University of New Mexico]: Gene Network Inference from Large-Scale Gene Expression good discussions and a list of articles. [with Incyte, NIH]

Michael P. S. Brown, William Noble Grundy, David Lin, Nello Cristianini, Charles Sugnet, Terrence S. Furey, Manuel Ares, Jr., David Haussler [UCSC]. Knowledge-based Analysis of Microarray Gene Expression Data Using Support Vector Machines. (SVMs are considered a supervised computer learning method.)

Pacific Symposium on Biocomputing 2000

Pacific Symposium on Biocomputing 1999

The Nature of GED (Gene Expression data); Experimental Variables (Dimensionality); Quality (Reproducibility) of GED; Extracting Signal from Noise; Statistical Approach; Artificial Intelligence-Based Approach; Interpretation of Results; Publicly Available GED (GEO, EBI, SAGE, ...)

Protein Chips (Protein Arrays)

The idea of protein microarray is not new. In fact, the basics and theoretical considerations of protein microarrays were done in the 1980's by Roger Ekins and colleagues. See, e.g., Ekins R.P., *J Pharm Biomed Anal* 1989. 7: 155; Ekins R.P. and Chu F.W., *Clin Chem* 1991. 37: 1955; Ekins R.P. and Chu F.W., *Trends in Biotechnology*, 1999, 17, 217-218.

There are two main objectives for proteomic research: 1. quantification of all the proteins expressed in a cell; 2. functional study of thousands of proteins in parallel. For quantification purpose, the standard method is 2D gel separation followed by MS identification. For protein function study, microarray-based assays are being used to study protein-protein and protein-ligand interactions.

News: Gavin MacBeath and Stuart L. Schreiber of Harvard University just published a paper on **protein microarray** - more than 10,000 protein spots were printed on a glass slide. The chip was used to identify protein-protein and protein-drug interactions. I believe it's a truly breakthrough for proteomics and for drug discovery. G. MacBeath and S.L. Schreiber, Printing Proteins as Microarrays for High-Throughput Function Determination, *Science* 2000 September 8; 289(5485): p. 1760-1763. Abstract The question is how to get thousands of pure proteins and keep them in their natural conformation.

Articles

1. BioInsights recently finished a strategic report on protein chips: sales of protein chips are likely to balloon from \$45 million in 2000 to almost \$500 million in 2006. [Press release](#).
2. MacBeath G. and Schreiber SL, Printing Proteins as Microarrays for High-Throughput Function Determination, *Science* 2000 September 8; 289(5485): p. 1760-1763. [Abstract](#)
3. de Wildt RM, Mundy CR, Gorick BD, Tomlinson IM. Antibody arrays for high-throughput screening of antibody-antigen interactions. *Nat Biotechnol.* 2000 Sep;18(9):989-994.
4. Irving RA, Hudson PJ. Proteins emerge from disarray. *Nat Biotechnol.*, 2000 Sep;18(9):932-933.
5. Aled M. Edwards, Cheryl H. Arrowsmith, and Bertrand des Pallieres, Proteomics: New tools for a new era, *Modern Drug Discovery*, 2000, Sept., 3(7) 34-44.
6. Kollol Pal, The Keys to chemical genomics, *Modern Drug Discovery*, 2000, Sept., 3(7) 46-55.
7. Joos TO, Schrenk M, Hopfl P, Kroger K, Chowdhury U, Stoll D, Schorner D, Durr M, Herick K, Rupp S, Sohn K, Hammerle H, A microarray enzyme-linked immunosorbent assay for autoimmune diagnostics. *Electrophoresis*, 2000 Jul;21(13):2641-50 [Medline]
8. Walter G, Bussow K, Cahill D, Lueking A, Lehrach H., Protein arrays for gene expression and molecular interaction screening, *Curr Opin Microbiol.* 2000 Jun;3(3):298-302.
9. Arenkov P.,Kukhtin A.;Gemmell A.;Voloshchuk S.;Chupeeva V.;Mirzabekov A., Protein Microchips: Use for Immunoassay and Enzymatic Reactions, *Analytical Biochemistry*, 2000, 278, 2, 123-131
10. Emili AQ and Cagney G. Large-scale functional analysis using peptide or protein arrays. *Nat Biotechnol.* 2000 Apr;18(4):393-7. Review. [Medline]
11. Ge H, UPA, a universal protein array system for quantitative detection of protein-protein, protein-DNA, protein-RNA and protein-ligand interactions. *Nucleic Acids Res.* 2000 Jan 15;28(2):e3
12. Lueking A, Horn M, Eickhoff H, Bussow K, Lehrach H, Walter G [Max Planck] Protein microarrays for gene expression and antibody screening. *Anal. Biochem.* 1999 May 15;270(1):103-111
13. Zong Q, Schummer M, Hood L, Morris DR. Messenger RNA translation state: the second dimension of high-throughput expression screening. *Proc Natl Acad Sci U S A* 1999 Sep 14;96(19):10632-6.
14. Mendoza LG, McQuary P, Mongan A, Gangadharan R, Brignac S, Eggers M. [Genometrix] High-throughput microarray-based enzyme-linked immunosorbent assay (ELISA). *Biotechniques* 1999 Oct;27(4):778-80, 782-6, 788. [Medline]
15. Brett D. Martin,* Bruce P. Gaber, Charles H. Patterson, and David C. Turner, Direct Protein Microarray Fabrication Using a Hydrogel "Stamper", *Langmuir*, 14 (15), 3971 -3975, 1998.

Related sites

- Dr. Konrad Büßow at Max-Planck-Institut für Molekulare Genetik
- Large Scale Proteomics Corporation, Rockville, MD, a subsidiary of Large Scale Biology Corporation.
- Ciphergen Biosystems, Palo Alto, California. ProteinChip™ Arrays for the investigation of proteins on the femtomole scale directly from their "native" environments. Based on Surface-Enhanced Laser Desorption/Ionization (SELDITM).
- NMI (Natural and Medical Sciences Institute), a protein array for autoimmune diagnostics.
- Proteome, Inc.
- Proteome Systems Ltd.,
- SenseTherapeutic Ltd., Cambridge, UK. COVET™ protein microarrays (Cloned Open reading frames for the Validation of Experimental Targets).
- ExPASy (Expert Protein Analysis System) proteomics server of the Swiss Institute of Bioinformatics (SIB).
- GeneBio (Geneva Bioinformatics S.A.)
- LumiCyties, Inc., Fremont, CA. SELDI BioChip based molecular profiling platform.
- Cambridge Healthtech Institute's conference on Human Proteome Project, April 2-4, 2001, McLean, VA.

Chemical Microarrays

1. Graffinity Pharmaceutical Design GmbH, Heidelberg, Germany. Uses chemical microarrays as screening tools to enhance the understanding of protein binding specificity, based on diversity Label-free Detection
2. Gregory A. Korbel, Gojko Lalic, and Matthew D. Shair*; **Reaction Microarrays: A Method for Rapidly Determining the Enantiomeric Excess of Thousands of Samples**, *Journal of the American Chemical Society*; 2001; 123(2); 361-362.
3. Eric LeProust et al., Digital Light-Directed Synthesis. A Microarray Platform That Permits Rapid Reaction Optimization on a Combinatorial Basis, *J. Comb. Chem.*, 2 (4), 349 -354, 2000.
4. Paul J. Hergenrother, Kristopher M. Depew, and Stuart L. Schreiber*; **Small-Molecule Microarrays: Covalent Attachment and Screening of Alcohol-Containing Small Molecules on Glass Slides**, *Journal of the American Chemical Society*; 2000; 122(32); 7849-7850
5. Gavin MacBeath, Angela N. Koehler, and Stuart L. Schreiber*; **Printing Small Molecules as Microarrays and Detecting Protein-Ligand Interactions en Masse**, *Journal of the American Chemical Society*; 1999;121(34); 7967-7968

Related Meetings / Workshops

Please suggest new links to be listed here.

- [Genome and Biotechnology Meeting Calendar at DOE's Oak Ridge National Laboratory](#)
- [IBC's Emerging Microarray Technologies and Applications, March 18-22, 2002, San Diego, CA,](#)
-

You missed:

- IBC 8th Annual [Biochip Technologies Conference - Chips To Hits, October 29 - November 1, 2001, San Diego, CA.](#)
- [smallTalk 2001: The Microfluidics, Microarrays, and BioMEMS Conference and Exhibition, August 27-31, 2001, San Diego, California, USA.](#) Sponsored by the Association for Laboratory Automation.
- [IBC's 6th Annual Drug Discovery Technology 2001, August 13-17, 2001, Boston, MA, USA](#)
- [EuroBiochips: Microarray and Microfluidic Technology Congress, June 5-8, 2001, Hilton Munich Park, Munich, Germany. \(IBC\)](#)
- [2001 Northwest Microarray Conference, Seattle WA.](#)
- [ABRF Microarray Survey: 2000-2001. An analysis of data submitted to this survey will be presented at the ABRF2001 meeting in February 2001](#)
- Bioinformatics Strategies for Application of Genomic Tools to Environmental Health Research, [March 5, 2001, National Center for Toxicogenomics \(NCT\), Raleigh, NC, USA. Accompanying symposium at NCSU.](#)
- [BIOCHIPS 2001 - Technology Development & Application, March 12 - 13, 2001, Brooklyn, New York, USA.](#)
- [Protein Microarray Technology, March 21-23, 2001 - San Diego, CA. \(IBC\). Keynote speaker: Prof. Roger Ekins](#)
- [3rd MGED: The Third International Meeting on Microarray Data Standards, Annotations, Ontologies and Databases, March 29-31, 2001, Stanford University, CA, USA.](#)
- Cambridge Healthtech Institute's conference on [Human Proteome Project, April 2-4, 2001, McLean, VA.](#)
- [Chemo*Bio Informatics, February 15-16, 2001 - Sheraton San Diego Hotel & Marina, San Diego, CA. \(IBC\)](#)
- Cambridge Healthtech Institute's Third Annual [Integrated Bioinformatics - High-Throughput Interpretation of Pathways and Biology, January 24-26, 2001, Zurich, Switzerland.](#)
- Cambridge Healthtech Institute's Third Annual [Lab-on-a-Chip and Microarrays for Biomedical and Biotechnical Applications, January 22-24, 2001, Zurich, Switzerland.](#)
- CAMDA'00 Conference: [Critical Assessment of Techniques for Microarray Data Mining, December 18-19, 2000, Duke University, Durham, NC,](#)
- IBC's 7th Annual [Biochip Technologies Conference - Chips To Hits, November 6-9, 2000, Philadelphia, PA.](#)
- [IBC's Biomics Congress, November 13-16, 2000, Stuttgart, Germany.](#)
- [2000 International Forum on Biochip Technologies, October 11-14, 2000, Beijing, China.](#)
- [The Northwest MieroArray Conference, September 6-8, 2000, The University of Washington, Seattle, WA.](#)
- [Duke Workshop: Functional Genomics and Microarray Data Mining, Aug 3-4, 2000, Duke University, Durham, NC.](#)
- CHI's [High Throughput Technologies, June 19-21, 2000, Philadelphia, PA.](#)
- [The Second International Meeting on Microarray Data Standards, Annotations, Ontologies and Databases, May 25 - 27, 2000, Heidelberg, Germany.](#)
- smallTalk2000: [The Microfluidics and Microarrays Conference, July 8-12, 2000, Hyatt Regency Hotel, San Diego, California, USA.](#) Sponsored by the Association for Laboratory Automation.
- Cambridge Healthtech Institute's first annual [Lab-Chips and Microarrays Japan, May 8-9, 2000, Tokyo, Japan.](#)
- Cambridge Healthtech Institute's first annual [MACRO RESULTS FROM MICROARRAYS: Establishing Leads for Drug Development, April 3-5, 2000, Cambridge, Massachusetts.](#)
- Genetix Ltd's [International Microarray Users Forum, November 16-18 1999, Burley Manor Hotel, Burley, Hants. UK.](#)
- 7th Conference on Small Genomes, [November 14-17, 1999, The Doubletree Hotel, Arlington, Virginia. Sponsored by the U. S. Department of Energy, The Office of Naval Research, and the National Science Foundation. There are some talks on DNA microarrays.](#)
- [Microarray Algorithms and Statistical Analysis: Methods and Standards, November 9-12, 1999, Granlibakken at Lake Tahoe, California.](#) This conference will be totally focused on the internals and methods of the mathematical and algorithmic side of sequencing and microarray analysis. It is not a forum for the presentation of new scientific data of a biological nature that is being generated using sequencing or arrays.
- IBC's [6th Annual Biochip Technologies Conference: Chips to Hits '99, November 2-5, 1999, Berkeley, California. This event will certainly be another big success.](#)
- There is a [Microarray Technology Workshop](#) being held at George Mason University (IB3, The Institute for Biosciences, Bioinformatics and Biotechnology) at George Mason University on [October 12-15, 1999.](#)
- [The Microarray Meeting--Technology, Application and Analysis, September 22 - 25, 1999, Mountain Shadows Marriott Resort Scottsdale, Arizona.](#) Confirmed speakers include most major players in this field. call BioEdge.Net (phone: US: +1-800-737-1333; International: +1-402- 996-9185) for information on submitting abstracts.
- [Association of Biomolecular Resource Facilities 1999 Meeting: Bioinformatics and Biomolecular Technologies: Linking Genomes, Proteomes and Biochemistry](#)
- [Lab Chips and Microarrays for Biotechnical Applications, January 1999 Zurich, Switzerland](#)
- [Stanford Bioinformatics Symposium](#)
- [IBC's Fifth Annual Conference on Biochip Technologies](#)
- [IBC's conference on Molecular Toxicology , April 29-30, 1999, The Watergate Hotel, Washington, D.C. \(many talks on DNA](#)

microarrays)

- [FDA seminar on microarray technology \(July, 1998\)](#) (Not accessible from outside of the fda.gov domain)

Stocks

In addition to the numerous inquiries I received on the technical part of DNA microarray I also received many requests from my visitors for investment advices. Unfortunately, I am not a financial adviser. However, I list here some of the stocks that are related to the DNA microarray technology in one way or another. *Warning:* This is FYI only and I shall not be held responsible for your investment outcome. If you think this site helped you make a good investment decision you are welcome to make a donation to maintain it and/or send my little kids some Pokemon toys :- Good luck!

[View All Stocks](#)

Affymetrix (AFFX)	AxyS (AXPH)	Caliper (CALP)
Celera (CRA)	Corvas (CVAS)	CuraGen (CRGN)
Gene Logic (GLGC)	Geneset (GENXY)	Genzyme Mol. Oncol. (GZMO)
GSI Lumonics (GSLI)	Hyseq (HYSQ)	Incyte (INCY)
JMAR (JMAR)	Lynx (LYNX)	Nanogen (NGEN)
Sequenom (SQNM)	SurModics (SRDX)	Vysis (VYSI)
Xenometrix (XENO)	Genomic Solutions (GNSL)	Orchid BioSciences (ORCH)

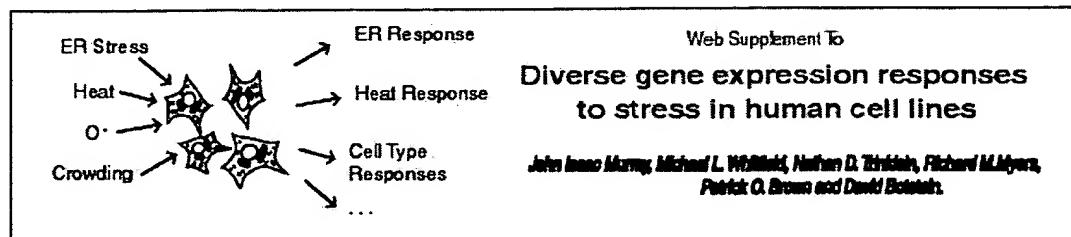
Others

- [Motorola, Packard Instrument Co., and Argonne National Laboratory to Develop Advanced Biochip Technology](#)
- [From DNA Chips to Potato Chips....](#)
- [Welcome to BioTech](#)
- Resources at [NCBI: BLAST, dbEST, Entrez, GenBank, MMDB, PubMed](#)
- [The Genome Database \(GDB\)](#)
- [GeneCards](#) is a database of human genes, their products and their involvement in diseases. It offers concise information about the functions of all human genes that have an approved symbol, as well as selected others. It is especially useful for those who are searching for information about large sets of genes or proteins, e.g. for scientists working in functional genomics and proteomics.
- [Myriad's Yeast two-hybrid system pathways](#)

Shoko Kawamoto, Tadashi Ohnishi, Hiroko Kita, Osamu Chisaka, and Kousaku Okubo [Osaka/Kyoto]. Expression Profiling by iAFLP: A PCR-Based Method for Genome-Wide Gene Expression Profiling. *Genome Res* 1999 Dec;9(12):1305-1312

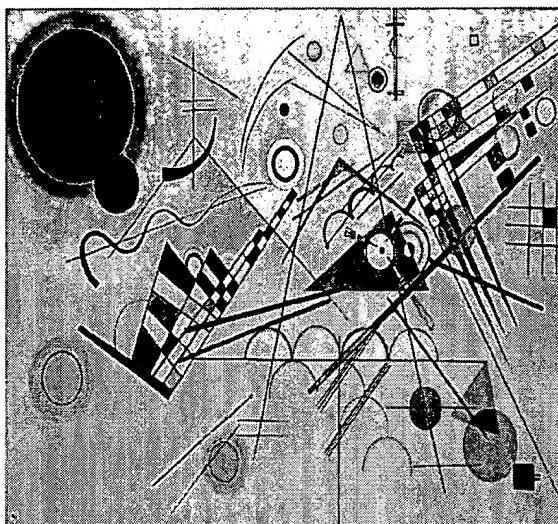
Wheeler DL, Chapple C, Lash AE, Leipe DD, Madden TL, Schuler GD, Tatusova TA, Rapp BA. Database resources of the National Center for Biotechnology Information, Nucleic Acids Res. 2000 Jan 1;28(1):10-4.

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Microarray protocols are available at the Brown Lab website

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